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NUCLEAR WEAPONS PROLIFERATION AND THE INTERNATIONAL ATOMIC ENERGY AGENCY

AN ANALYTICAL REPORT

PREPARED FOR THE

COMMITTEE ON GOVERNMENT OPERATIONS
UNITED STATES SENATE

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NUCLEAR WEAPONS PROLIFERATION AND THE INTERNATIONAL ATOMIC ENERGY AGENCY

A report by the Congressional Research Service
to the Senate Committee on Government Operations

By
Warren H. Donnelly, Senior Specialist - Energy
and
Barbara Rather, Reference Assistant
Environment and Natural Resources Policy Division

March 1976

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Washington, D.C. 20540

March 3, 1976

The Honorable Abraham Ribicoff
Chairman, Committee on Government Operations
United States Senate

The Honorable John Glenn
Ad Hoc Chairman for Nuclear Affairs
Committee on Government Operations
United States Senate
Washington, D.C. 20510

Dear Senators Ribicoff and Glenn:

I am submitting the enclosed report, "Nuclear Weapons Proliferation and the International Atomic Energy Agency", which was prepared at your request for use in connection with S. 1439, the Export Reorganization Act of 1976. This report is the third of a series submitted to your Committee this year. Its purpose is to analyze the role of the International Atomic Energy Agency in limiting further proliferation of the ability to make nuclear weapons.

The research and analysis were done by Dr. Warren H. Donnelly, Senior Specialist, with the assistance of Ms. Barbara Rather, Reference Assistant.

We hope this report will be of assistance to the Committee.

Sincerely,

Norman Beckman
Acting Director

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I. PURPOSE AND SCOPE OF THE REPORT

The purpose of this report is to analyze the role of the International Atomic Energy Agency (IAEA) in limiting the future proliferation of the ability to make nuclear weapons in a world committed to the increasing use of nuclear power. The report is the third* in a series of publications prepared for the Senate Committee on Government Operations for use in its consideration of S. 1439, the Export Reorganization Act of 1976, and in its oversight of U.S. participation in international agencies--in this case, the International Atomic Energy Agency.

The report briefly reviews the problem of proliferation, its current status and factors affecting it, and recent congressional interest; and looks at IAEA and its role in limiting proliferation. It considers what can be expected of the IAEA, and what cannot, safeguards, the role of the IAEA for protecting nuclear materials and facilities against theft or sabotage, and the role of the IAEA in multinational, regional fuel cycle centers. The report concludes with discussion of some ways to strengthen the IAEA in its nonproliferation functions.

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* The first two reports were:

U.S. Congress. Senate. Committee on Government Operations. Facts on nuclear proliferation: A handbook. 94th Cong., 1st sess., 1975, 259 p. (Committee print.)

U.S. Congress. Senate. Committee on Government Operations. United States agreements for cooperation in atomic energy: an analysis. 94th Cong., 2d sess., 1975, 60 p. (Committee Print.)

II. SUMMARY DISCUSSION AND OBSERVATIONS

The IAEA and proliferation

On the whole, the information available indicates that the IAEA is performing a necessary function through its systems of nuclear safeguards, a function that would have to be invented now if it did not exist. The Agency could perform other functions in support of non-proliferation goals. Whether the benefits from additional or expanded IAEA functions would be enough to persuade the world community of nations to authorize and support them is an unanswered question. For the United States, the likely benefits appear to warrant consideration of strong U.S. diplomatic initiatives to rally the international support necessary to authorize an expanded role and to prepare the Agency to fulfill it.

The IAEA's safeguards systems are not perfect and need to be improved. They will be inadequate to safeguard the flows of nuclear materials expected in the 1980s. Little time remains to make the organizational, financial and other arrangements needed for IAEA safeguards to keep in step with expanding world use of nuclear power.

At the request of the Committee on Government Operations, the Congressional Research Service has analyzed the potential role of the International Atomic Energy Agency in limiting future spread, or proliferation, of the ability to make nuclear weapons in a world increasingly committed to the civil use of nuclear power. The analysis draws upon the hearings of the Committee and hearings of several other congressional committees, a recent report of the U.S. Comptroller General, impressions of the author at a recent IAEA symposium on safeguards, and recent literature.* It necessarily reflects the judgment of the author, so there is some likelihood that others may differ with its conclusions on some matters. Within this limitation, the analysis seeks to objectively identify for congressional attention matters and issues related to the future of the IAEA and how it might be able to help limit future proliferation.

Proliferation redefined

Thirty years ago proliferation was viewed largely as the actual production of nuclear weapons by nations other than the United States. Today, now that six nations have nuclear explosives, the term has been expanded to include the further spread of the capability for making nuclear weapons, particularly the spread to non-weapons nations of facilities to produce weapons-grade materials, whether by enrichment of uranium or recovery of plutonium from spent fuel. The broadening of meaning opens prospects for some new roles for the International Atomic Energy Agency in limiting and dealing with proliferation.

Overexpectation: a fundamental problem

On the whole, the greatest difficulty faced by the IAEA, and a potential limitation to an expanded role in dealing with proliferation, is overexpectation. The Agency is not and cannot be a magical way to relieve the world of problems of proliferation. It is not superhuman, nor should it be. The Agency is a finite, human institution that exists with the forbearance and support of its member states. It has the strengths and weaknesses of any national or international organization. Overexpectation, however, can lead to unjustified disappointments, malaise, and frustration that may possibly discourage practicable actions by the United States and other IAEA member states to make the Agency more effective in dealing with proliferation.

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* With the sponsorship of the Committee, the author attended the International Symposium on the Safeguarding of Nuclear Materials held by the IAEA in Vienna, October 20-24, 1975.

Looking at the IAEA today, it appears reasonable to expect it to provide:

--Substantial assurance that the theft or diversion of significant amounts of fissionable materials from peaceful to military uses or to weapons will be detected and announced.

--Advice and assistance to states that wish to set up or to improve their national safeguards systems.

--A working demonstration of international inspection for verification of treaties.

--Assistance in expanding the civil use of nuclear power throughout the world.

However, with the functions and powers granted to it by its member states, the IAEA cannot reasonably be expected to:

--Provide absolute assurance that any theft or diversion or loss of fissionable materials will be detected.

--Provide the physical protection of nuclear materials and facilities against attack or sabotage.

--Pursue and recover stolen nuclear materials.

--Detect clandestine production of nuclear materials.

--Compel states to ratify the Non Proliferation Treaty.

--Regulate world nuclear exports.

--Apply sanctions against states that divert nuclear materials to illicit purposes, or punish other persons or groups that steal nuclear materials.

While it would be pleasant to propose the Agency should lift the burden of proliferation, what can be expected from the Agency in real life is governed by what its member states would be willing to authorize and support. The United States is one member among many. For the United States to substantially change the present IAEA role would require a diplomatic effort strong enough to convince many very different nations that our ideas would sufficiently benefit them to win their support. This is not to say change is impossible, but rather that change in the IAEA is likely to come slowly and by increments, unless compelled by unexpected world events.

In considering ways to deal with proliferation if world use of nuclear power expands as now expected, the most demanding problem is for Congress and the executive branch to define attainable goals for nonproliferation, to agree upon what is expected of the IAEA, and to decide what the United States can do by international and unilateral action. This done, decisions about the Agency, its international statute, organization, operations, funding and other resources can follow logically.

The IAEA and arms control

Control of nuclear armament and other weapons of mass destruction is recognized as an essential element in limiting proliferation of nuclear weapons. Non-weapons states will be less likely to decide to opt for nuclear weapons if the world arms situation does not push them to acquire a nuclear capability. For years one sticking point in negotiation of arms controls systems has been verification through inspection. While this problem seems unlikely to disappear soon, the continuing experience with the inspectorate of the IAEA should demonstrate that international inspection need not be objectionable in its performance and that international inspectors can work without political bias.

The potential role of the IAEA in limiting proliferation

The IAEA has a necessary present and future role in limiting proliferation by reducing pressures on states to make nuclear weapons through assurance that diversion or theft of nuclear materials in neighbor states will be detected and announced. This function is a necessary but not a sufficient condition. The Agency could play a larger role in helping to limit the spread of the ability to make nuclear weapons. Whether national and public perception throughout the world of risks of proliferation will generate the impetus for such change remains to be seen. The most likely new roles for the IAEA could include helping to reduce pressures for nuclear independence, preventing the export of certain critical items and technologies, and assessing the adequacy of physical security for nuclear materials and facilities. There appears little prospect that the Agency's role in non proliferation could include dissuading states from decisions to make nuclear weapons, or providing an international police response to diversion or theft.

Reducing pressures for nuclear energy independence

With the lessons of the present international oil supply situation in mind, more nations are likely to opt for nuclear independence, thereby enabling them to acquire nuclear weapons materials. By action of its member states, the IAEA could be assigned several functions to help to counter this trend. Worth consideration are the following functions:

World nuclear fuel brokerage.--Some countries would prefer not to deal directly with supplier nations which they might consider as unrepentent colonial powers. Other nations would prefer to have their arrangements for nuclear fuels and services insulated from the impacts of changing international tensions. As a world broker for nuclear materials and services, the IAEA could function as an international, neutral middleman. It could offer an alternative to distasteful direct relations and provide assured sources of supply insulated from temptations of supplier nations to use the leverage of their position to obtain non-nuclear concessions from customer nations. As a world broker, the Agency could own and manage a stockpile of nuclear fuel materials sufficiently large to assure continued supply during times of political or diplomatic tensions that might cut off direct supplies. Perhaps the IAEA as a world broker could exchange enriched uranium with non-weapons customer nations for plutonium recovered from their used fuels so that their fuel cycles would not contain weapons-grade materials. The plutonium would then be used only in weapons states. This function assumes, of course, that the future use of plutonium as a fuel will indeed be both permissible and feasible.

The advantage of a brokerage function for the IAEA would be to make nuclear interdependence palatable to more nations, to reduce the need for non-weapons nations to use plutonium as a fuel, and to provide the Agency with some independent income for its safeguards function through brokerage fees. The disadvantages would include the effect of regulating free world nuclear trade, and possible loss of supplier nation sales contacts and influence with customer nations.

World nuclear export control.--The IAEA now has only an informal voice in deliberations of nuclear supplier states as to common policy on nuclear exports or for subsequent individual exports. It does serve as a public repository for unilateral statements of parallel policy by supplier states. Considering the effect on proliferation of spreading capability to produce weapons-grade nuclear materials, the IAEA could further help limit this spread by making public advisory reports to supplier nations on certain types of nuclear exports. To do so would require the supplier nations to inform the Agency of such exports, to provide time for Agency review and comment, and to seriously consider its advice. The IAEA could perform a review and adversary function similar to that proposed for the U.S. Arms Control and Disarmament Agency in Senate bill S. 1439. A more radical approach would be to require supplier states to obtain an IAEA export license or approval for classes of export determined by the Agency.

The advantages of such a function would be to further reduce the chances of nuclear exports that could undesirably add to the ability of non-weapons nations to make nuclear weapons, or to reduce chances for unilateral departure from the informal common export control policies. The disadvantages would be interference in world trade and possible politization of the Agency over controversial actions.

Promotion of multinational nuclear fuel facilities.--Another alternative to nuclear independence for non-weapons states is the establishment of multinational nuclear fuel facilities. Such facilities presumably could offer a reliable supply of nuclear materials and services that could be more attractive to some states than that offered by individual nuclear exporting nations. At present the IAEA s role would be limited to application of its safeguards to such facilities. In the future, its function could be expanded to include some part of the promotion, planning, financing, design, construction and operation of multinational centers.

The advantages of an expanded IAEA role would include the potentially greater acceptability to many nations, the potential saving in time and resources needed to establish new international organizations for such facilities, the greater assurance that nuclear materials would not be diverted, and benefits of the Agency's extensive experience with nuclear safeguards. The disadvantages would include possible unfavorable impact of such functions on the IAEA s staff and resources available for safeguards, and the creation of a troublesome conflict of interest within the Agency between those concerned with operations of the center and those concerned with its safeguards.

Issues and opportunities for IAEA safeguards

An overview.--The IAEA presently has two safeguards systems: one for states that have ratified the Non-Proliferation Treaty (NPT) and one for other states. Together, these systems provide substantial but not absolute assurance that diversion or theft of significant amounts of fissionable materials from safeguarded activities will be detected and announced. How well the systems have kept pace with world growth of nuclear energy is an open question. However, the present systems clearly will be insufficient to adequately safeguard the numbers of sensitive nuclear facilities and the amounts of fissionable materials that are forecast for the 1980s and beyond.

The appearance of commercial fuel reprocessing plants and the anticipated growth in uranium enrichment plants will greatly complicate national and IAEA safeguards. Nuclear powerplants alone pose relatively little risk for diversion or theft of nuclear materials unless highly enriched uranium, uranium-233 or plutonium come into use as fuel.

Opportunities exist to improve the effectiveness of present and future IAEA safeguards. Prompt action must be considered to further these opportunities because of the comparatively long lead times necessary to bring about the desired improvements. Actions deferred until safeguards problems become critical are too likely to be hasty, insufficiently thought out responses, probably too little and too late. However, despite the urgent need for effective safeguards expressed by witnesses before the Committee, the issues of safeguards remain unknown to the general public. So, the prospects are for slow and incremental improvements or changes in IAEA safeguards and the Agency resources to apply them.

IAEA safeguards have limitations and imperfections. A recent report from the U.S. Comptroller General identifies many. IAEA officials also see both limitations and opportunities for improvement and expect a continued evolution toward greater effectiveness. No witnesses, however, proposed abolition of IAEA or its safeguards functions. Some critics of IAEA safeguards would have the Agency exceed the functions and powers in its statute. Assuming the Agency could and would exceed its authority, it would then start down a road to uncontrollability and usurpation of power. So, criticism based upon perceived inadequacies in the Agency's statutory authority could better be directed toward measures to amend the statute.

The Comptroller General's report.--The Comptroller General, in his report on the role of the IAEA in safeguarding nuclear materials, arrived at conclusions which indicate limitations and shortcoming of the IAEA's safeguards. The many issues he raised warrant Congressional attention, as do the three major policy matters he identified.* In particular, the reasons for the pessimistic tone of his report merit careful exploration and consideration.

Anticipating technological surprise.--The projected requirements for future safeguards systems and organizations and their probable effectiveness assume that future evolution of nuclear technologies will be without upsetting technological surprise. Yet there is the possibility of unanticipated technological advances that could substantially transform the risks of proliferation and the demands imposed upon safeguards. Several still-infant nuclear technologies that could present such a technological surprise include the centrifuge and the laser processes for uranium enrichment, and the use of fusion reactors as large sources of cheap neutrons to convert uranium-238 into plutonium, or thorium into uranium-233. Likewise, a breakthrough in the presently discouraging economics of peaceful nuclear explosives could generate a real demand for these devices that would be unsettling to proliferation.

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* The three policy issues raised included: (1) the need for expanding Agency responsibilities in the physical protection of nuclear material, control of nuclear waste, and safe transport of nuclear material internationally; (2) the technical and political limitations in applying Agency safeguards; and (3) the lack of sufficiently strong penalties or sanctions on a country that diverts nuclear material to military purposes or that knowingly supplies material to another country for developing nuclear explosive devices. In addition, the Comptroller General proposed an annual IAEA report showing, by member country, the amount of nuclear materials subject to its safeguards and the amount and/or percentage of material which could not be accounted for during Agency inspections, while not divulging host country proprietary information.

At issue is to what extent and in what ways it is desirable and feasible to anticipate possible technological surprise in planning for IAEA and national safeguards systems.

Separation of the IAEA functions.--The IAEA presently combines promotional and control functions for nuclear energy. Some observers see inherent conflicts of interest within the Agency itself and reflected among the member states. Other observers and IAEA officials believe the combination of functions adds to their performance and should be preserved. Proposals have been made to separate the safeguards function, presumably into a new international agency. These proposals draw upon analogy with the recent separation of domestic promotional and regulatory nuclear functions by Congress in the Energy Reorganization Act of 1974.

At issue is how closely the analogy of U.S. experience applies and, if it should appear desirable to consider separation, whether the United States could muster the international support to achieve it.

Inspection vs. social technologies for verification.--Since the NPT came into force, the IAEA safeguards system for NPT countries has tended to substitute social technologies systems for human inspections to avoid political objections to free and unlimited access by IAEA inspectors.* On the other hand, the international statute of the IAEA emphasizes free and unlimited inspection. As more nations ratify the NPT, their nuclear activities under IAEA safeguards may receive less inspection. While this trend would reduce the required financial support for future IAEA safeguards, at issue is the extent to which systems analysis can substitute for, rather than supplement, on-site inspection and still preserve required reliability. At issue also is whether the objective of protecting national nuclear trade secrecy by restricting access of IAEA inspectors is worth the possible adverse effects on public perception of the reliability of IAEA safeguards.

Technology for nuclear safeguards.--There appears to be more safeguards technology on hand and being developed than is presently in use in IAEA and national safeguards systems. Still more is being created. The United States leads the world in the scope and diversity of, and support for safeguards research and development. However, there do not appear to be specific goals for development of safeguards technologies nor consideration of how these developments can be put into practice. Nor is it clear how far technology can improve the accuracy of measurements and limits of error. For example, the Los Alamos Scientific Laboratory is working to improve non-destructive analysis. It has the idea of ultimately developing for each nuclear facility a plantwide network of on-line measurement and verification instruments connected to a computer-operated materials accountability and control system, the DYMAC system.* If Los Alamos succeeds and the systems can be applied, facility operators would have almost instant warning of detectable removals. This would force would-be diverters to commit many small thefts with a concomitant high risk of detection by accounting and physical protection systems.

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* The term "social technologies" refers to use of systems, statistical and probability analyses.

Several issues emerge:

--What technological improvements should be developed and applied by the 1980s to deal with expected production, flows and use of fissionable materials?

--To what extent can and does the IAEA participate in planning of safeguards research and development by U.S. agencies?

--How is U.S. safeguards research and development coordinated among the agencies involved and with what success?

--How should future U.S. support for safeguards research and development be divided between the IAEA and U.S. agencies?

--What measures are there to quickly and effectively transfer new safeguards technology into practical worldwide use?

Physical security for nuclear materials and facilities

United States' concern that physical security for nuclear materials and facilities may be inadequate to prevent armed robbery or sabotage seems to have caused other nations to start thinking about this problem. However, the IAEA and most other national safeguards systems do not include physical security as a safeguards function. The assumption is that national police forces can provide whatever security is necessary. The furthest the IAEA has gone is to publish a guide for physical protection.

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* Dynamic Materials Control system.

At issue is the whole question of the future role of the IAEA in physical security. Should it be purely advisory? Should it be expanded to the setting of standards and inspection to verify compliance with standards? Should the IAEA itself provide physical security for materials in international transit and perhaps even for international facilities or upon request for national facilities? The U.S. answers to these questions can be expected to further influence world thinking on this matter.

Secrecy of safeguards information

Much of the documentation for IAEA safeguards systems and the reports of its inspectors are concealed from the public and from IAEA member nations by strict secrecy. While the secrecy reduces risk of possible economic loss of nuclear trade secrets by the safeguarded states, it leads to observations, such as that of the Comptroller General, that the real effectiveness of Agency safeguards is not known and there is no public evidence to show whether Agency safeguards have prevented or detected diversion of nuclear material from intended peaceful purposes.*

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* It should be noted that in the United States, safeguards reports of NRC inspectors are not in the public record and that the question of what information should be published on materials unaccounted for in licensee inventories has yet to be decided by the National Security Council.

At issue is the possibility of reducing the secrecy for the supplementary documents to IAEA safeguards agreements, and the extent to which some information from IAEA s inspector reports should be regularly given to the Agency's Board of Governors and to the world public.

Coordination of national and IAEA safeguards systems

The IAEA s safeguards system for NPT states depends in part upon establishment of a national system in the safeguarded state. Yet the IAEA lacks authority to prescribe minimum standards for national systems and there are few examples of coordination between IAEA and national systems. If IAEA safeguards are to depend in part upon national systems, then it appears desirable for the IAEA to have clear authority to set standards and to achieve coordination. Of interest would be analysis of reasons why the Agency does not now have such authority and whether U.S initiatives could overcome these obstacles to obtain such authority for the Agency.

Financing of IAEA safeguards.--IAEA safeguards are financed through the Agency's budget which is funded by assessment of member states and by voluntary contributions. In a sense, IAEA safeguards compete for funds with other Agency programs and in a tight budget situation, every dollar added to safeguards is probably deducted from another function. Many of the member states are more interested in the IAEA's development and informational activities than in safeguards and resist expansion of the safeguards budget. They would prefer the nuclear power states to pay more or most of the costs of safeguards. The U.S. position is that safeguards costs should be borne generally by all members.

At issue is the extent to which the anticipated future IAEA safeguards organization can be financed through the present system. Will an alternative source of funding, such as a charge per kilowatt hour of nuclear electricity generated in safeguarded states, or licensing fees for nuclear facilities, be needed, and what are the prospects for attaining it? What can the United States do to assure adequate future funding?

IAEA safeguards for U.S. exports

The first U.S. nuclear exports were subject to direct U.S. safeguards and inspection in the importing country. Then following a policy decision to strengthen the embryonic IAEA safeguards functions, the United States began to transfer application of safeguards for U.S. exports to the IAEA. The Agency did benefit from this experience, which was instrumental in generating its expanded safeguards functions under the NPT. However, the United States lost the direct safeguards control it initially had. Moreover, the United States is not provided with information on the IAEA inspections, nor has it access to the secret supplementary documents that contain the details of IAEA safeguards. Some observers have raised the issue whether this situation provides the United States with adequate assurance that its nuclear exports to nations not party to the NPT will not be diverted to military or weapons purposes.

III. PROLIFERATION: A PROBLEM OF THE NUCLEAR AGE

Public and legislative concern over the spread of nuclear weapons among the nations of the world peaked quickly in the late 1940s following the United States' use of nuclear weapons against Hiroshima and Nagasaki in 1945 and during debates in the United Nations Atomic Energy Act of 1946. This concern revived again in the mid-1950s as the nuclear arms race between the United States and the Soviet Union expanded and the tensions of the cold war led to President Eisenhower's Atoms for Peace Proposals with its plan for a world pool of nuclear materials administered by an international agency. The concern with proliferation then subsided until the early 1970s when in the United States public interest groups opposing nuclear power began to express their fears about risks of theft or diversion of nuclear materials and proliferation. Their efforts together with the detonation of a "peaceful nuclear explosive" by India in May 1974 and President Nixon's proposals of substantial nuclear power assistance to Egypt and to Israel as incentive to end the conflict between these nations have again brought proliferation back into the arena of public discussion, debate and congressional attention.

The problem of proliferation

What is the problem of proliferation? Simply put, it is fear of the consequences of the further spread of nuclear weapons, or the ability to make them, among the nations of the world. More recently this fear has expanded to include terrorist or extremist use of nuclear explosives. Some of the specific concerns encompassed within this overall concern include the following:

(1) The increased possibility, if proliferation continues, that lesser nations might use nuclear weapons for political or self-defense reasons and thereby trigger a global nuclear war.

(2) The impact upon world society of the effects of limited use of nuclear weapons if general nuclear war did not result.

(3) Changes in regional world power relationships in unforseeable ways as a result of potential, threatened, or actual use of nuclear weapons.

(4) World confusion in deciding what to do if nuclear explosives are used for destruction or for blackmail by unidentified parties.

(5) Increased complication and difficulty in reaching arms control agreements by major world powers.

(6) The possible use of nuclear explosives by terrorist or other dissident organizations which might provoke dangerous international confrontations or even trigger general nuclear war.

(7) The probable increase in instability and uncertainty in international relations from fear of irrational use of nuclear weapons by unscrupulous or irresponsible government officials who might have access to them.

These concerns are increased by prospects of expanding world use of nuclear fuels in the coming decades and a growing international commerce in nuclear power facilities which could make proliferation easier and more likely.

On the whole, because all knowledge of nuclear fission and its technologies cannot be erased from the peoples of the world, their academic and industrial institutions and their governments, the best that can be hoped for is to make further proliferation slow, difficult and undesirable. Slowing proliferation can buy time for the evolution of world society to a stage where nations will no longer consider nuclear weapons essential to their political goals and national security, and where new energy sources can decrease the need for nuclear power. The International Atomic Energy Agency can play an important part in limiting future proliferation, but cannot be expected to do everything necessary. As mathematicians would say, it is a necessary but not a sufficient condition for solution of the problem. Whether the time bought by measures to slow proliferation will be enough to arrive at an effective and reliable solution is by no means sure, so there is no time to be lost.

Some conceptual approaches to limiting proliferation

The most radical measure to lay to rest fears of proliferation would be to remove fissionable matrials from the hands of mankind. This would require all nations to collect all nuclear materials from weapons and other uses, to disperse these nuclear materials back into nature in some non-recoverable manner, to dismantle all nuclear energy facilities, seal all uranium mines, and absolutely prohibit any further production or use of any nuclear material for any purpose. If this can not be done, then mankind and its nations must learn to live with nuclear materials, with proliferation, and, sooner or later, with the possible misuse of nuclear energy. Failing to remove fissionable materials from the scene, the path into the future soon forks, with one branch leading toward a future formed by a do-nothing approach, and the other leading toward deliberate measures to keep proliferation within bounds acceptable to world society.

In addressing the role of the International Atomic Energy Agency in limiting proliferation, a point of departure is an identification of the range of measures for control of proliferation which can be considered. For this analysis, such measures have been classified according to five major purposes, which are to limit proliferation by:

(1) Reducing pressures on national governments to decide to acquire nuclear weapons.

(2) Limiting the spread to more countries of those parts of the nuclear fuel cycle which can most directly enable a nation to quickly make nuclear weapons.

(3) Making it harder to steal or divert nuclear materials.

(4) Making more probable the detection and announcement of theft or diversion of nuclear materials.

(5) Developing and applying alternative energy sources to reduce the demand for nuclear power.

Table 1 suggests a range of typical measures for these purposes. Many have been proposed by students of arms control, disarmament and proliferation. The list omits radical but unlikely measures such as attempting to erase nuclear power from the world, to accomplish immediate and total world nuclear disarmament, or to place ownership and operation of all resources and facilities for nuclear energy throughout the world in the hands of an international agency. Such proposals make for interesting speculation but do not appear likely possibilities in present circumstances. How feasible they might appear after further proliferation, or an unforeseen use of nuclear weapons is an even more speculative matter.

Table I : List of Possible Means to Limit Proliferation

I. Reducing pressures for proliferation

- --Convince non-weapons nations that nuclear weapons are not necessary for their security
- --Step up nuclear disarmament and arms control. Divert weapons material to power production
- --Conclude an effective comprehensive nuclear test ban treaty
- --Cause more nations to ratify the NPT and forswear nuclear weapons
- --Improve ways for nations to settle disputes without resort to threats or use of nuclear force
- --Provide assurance against undetected development of nuclear weapons
- --Establish enforceable sanctions against nations that prepare to or begin to make nuclear weapons
- --Get nuclear weapons nations to pledge no first use of nuclear weapons against non-weapons states

II. Limiting the spread of the ability to make nuclear weapons

- --Encourage nuclear interdependence to prevent proliferation of capabilities to make fissionable materials
- --Establish multinational, regional nuclear fuel cycle centers
- --Have nuclear supplier nations offer reliable nuclear fuel services
- --Establish a cartel of nuclear supplier nations to restrict the export of nuclear fuel cycle technology and products to NPT nations and to sell nuclear fuels and fuel services at prices below those national enterprises would have to charge
- --Reestablish a U.S. dominance in the world nuclear fuel cycle market by expanding facilities and charging prices low enough to discourage national fuel cycle ventures.
- --Speed up and increase development of nuclear fuel cycles that do not contain materials readily usable for nuclear explosives.

III. Making theft or diversion more difficult

--substantially increase physical security for nuclear materials and critical facilities

--Establish an international security force for nuclear materials both within nations and at multinational centers

--Establish national and international means to anticipate and intercept attempted theft or diversion, and to pursue and recover stolen materials

--Establish theft of nuclear materials as an international crime

--Limit nuclear fuel exports to nations to normal or low enriched uranium. Prohibit their use of plutonium, uranium-233 or highly enriched uranium

--Store, rather than reprocess, nuclear fuels, so that plutonium will not be recovered. Pay non-weapons nations for fuel value of plutonium and unrecovered utanium in their fuel

--Limit use of breeder reactors to weapons nations or to operation by multinational organizations

IV. Making more certain the detection and announcement of theft or diversion

--Improve national and international safeguards systems and technologies to promptly and reliably detect and announce theft or diversion

--Openly publish results of safeguards audits and inspections

V. Developing world alternatives to nuclear energy

--Create economically feasible alternatives to expanded use of nuclear energy including solar energy, wind power, and fusion

--Offer technical assistance in non-nuclear energy only to nations that adhere to the NPT

Varieties of proliferation

A decade ago Herman Kahn stimulated thinking about massive nuclear weapons attacks in his book Thinking about the Unthinkable. In some ways, identifying and discussing the range of measures that could be considered for dealing with nuclear proliferation is also an adventure in thinking of things that are uncomfortable, disturbing, even horrifying to think about.

The world proliferation has begun to acquire different meanings. Three types of proliferation include:

--Vertical proliferation by nuclear weapons states, which means the increase or other change in world arsenals of nuclear weapons.

--Horizontal proliferation, which means the future acquisition of nuclear weapons by states that do not have them now.

--Non-government proliferation, which means the acquisition of nuclear explosives or terror devices by extremist, terrorist or other groups not operating under authority of an established national government.

The first two kinds of proliferation have been a matter of serious international concern since World War II. The third has become a matter of concern since the emergence of terrorism as a way for so-called subnational groups to attain their goals. The three forms of proliferation are interrelated and actions taken for one are likely to affect the others. So while this overview deals mainly with horizontal and non-governmental proliferation, the reader should keep in mind the possibilities for interaction with problems of vertical proliferation.

Proliferation today

At the outset of 1976, six nations possess nuclear weapons or devices: the United States, the Soviet Union, the United Kingdom, France, China, and India. Of these, the United States, the Soviet Union and India have tested so-called peaceful nuclear explosions.

While nuclear power is spreading in the world, nuclear fuel now in use is slightly enriched or normal uranium neither of which is a nuclear explosive. Plutonium is being created in nuclear fuel irradiated in power reactors; however no commercial fuel reprocessing plants are in operation facilities. So access to this material for theft or diversion is limited. A few experimental breeder reactors use highly enriched uranium or plu-Atomic Energy Agency, a nuclear supplier nation and the user nation, or plants is small.

On the whole, current access to plutonium or to uranium-233 or highly enriched uranium is distinctly limited both for nations and for dissident groups. These materials are not yet routinely present in nuclear industries but can be expected in the 1980s and beyond.

The changing nature of horizontal proliferation

At first the proliferation of greatest concern was the production of nuclear weapons by additional nations. Now this concern is changing with the spread among additional nations of the industrial base to quickly produce nuclear weapons.

To make nuclear weapons, a nation needs a supply of fissionable materials plus manpower and facilities capable of designing and fabricating weapons. The more scientists and engineers a nation has who are experienced in the use and handling and fabrication of fissionable materials, and the more facilities it has that can produce and fabricate fissionable materials, the quicker that nation can produce nuclear weapons if it so chooses. manpower can come from a civil nuclear power program while facilities Much of the trained needed for nuclear power independence could be readily diverted to production of weapons. As for the information needed to design weapons, the fact that six nations to date have produced nuclear explosive devices establishes beyond doubt that weapons can be made. Much of the basic information about their design is in the open literature, particularly for what would now be considered crude devices. The successful design and production of small, compact, high-yield devices by inexperienced groups, however, seems unlikely because of the sophistication, detailed information and testing required.

As for possible acquisition of nuclear weapons by dissident groups, the likelihood of this new form of proliferation will depend upon many factors which include:

(1) The amounts and distribution of weapons-grades materials present in civil nuclear power industries.

(2) The physical security and protection provided for such materials and facilities, particularly for materials in transit.

(3) National and international abilities to anticipate and intercept attempts at theft, and to pursue and recover stolen materials.

(4) The ability of dissident groups to design and make a usable nuclear device, and to deliver, install and use it without prior detection.

(5) The present tendency of some nations to condone terrorist acts in the name of national liberation that they would not otherwise tolerate.

Generally, the spread of national facilities for uranium enrichment, fuel reprocessing, storage of fissiionable materials and fabrication of plutonium into nuclear fuels would increase the opportunities for theft by dissident groups. The imposition of national and international controls over the actions of such groups, and the provision of strong national physical security systems would decrease such opportunities.

Today many nations have the industrial base and funds to undertake production of nuclear fissionable materials for weapons if they choose to. For many of these nations, the effort would be long, drawn-out, subject to detection or premature discovery, and would probably produce comparatively small amounts of materials. The possession of nuclear power reactors to date has not provided such nations with an easy pathway to nuclear materials. However, there appears to be a growing interest in many countries, especially in the wake of the Arab Oil Embargo of 1973-74, to reduce their dependence on imported oil by developing nuclear power, and to seek nuclear independence by acquiring the means to reprocess irradiated fuels to recover and use plutonium. The possession of this industrial capability and the implied capability to fabricate the recovered plutonium into nuclear fuel would put possessing nations in a position to telescope the time needed to produce nuclear weapons. In many ways, the potential further spread of the industrial facilities for use of plutonium as a nuclear fuel will become a form of horizontal proliferation almost equivalent to the actual spread of the manufacture of nuclear weapons. Enrichment of uranium would be another route to weapons, but this technology appears more demanding than that for plutonium production.

Proliferation in the 1990's

The risks of further proliferation of the industrial nuclear base or of actual production of nuclear weapons will increase in the future, assuming that nuclear power grows as forecast, that plutonium comes into use as a commercial nuclear fuel, and that the breeders become commercially feasible. These assumptions taken together would indicate that an era of substantially increased potential risks of proliferation is likely to begin in the 1990's. Such timing allows some ten to 15 years to devise and bring about improvements in safeguards and other measures to limit proliferation. This is not long when one recalls that the period of gestation for the International Atomic Energy Agency was three and a half years from President Eisenhower's Atoms for Peace speech in December 1953 to establishment of the IAEA in July 1957, and that many more years were required for the infant agency to develop its role in safeguarding nuclear materials and facilities. The remaining time also is short in comparison with the seven to ten years required to license, design, build and start up a nuclear powerplant in the United States, and the probable five to seven years to establish fuel cycle facilities such as new enrichment plants, fuel reprocessing plants and high-level waste storage facilities.

The risk of proliferation in the future will be least if enough uranium is found in the years ahead to reduce pressure to use plutonium as a fuel and to build breeder reactors. If uranium is plentiful, nuclear fuels can be used and stored indefinitely until a time when recovery and use of plutonium is more attractive and when safeguards and other non-proliferation measures are more reliably established.

The risk of proliferation will be greatest if discoveries of uranium do not keep pace with the growth of nuclear power. In this situation the pressure to quickly build breeder reactors with the concomitant recovery and reuse of plutonium or uranium-233 for nuclear fuel will bring closer the time when large amounts of weapons-grade nuclear materials can be expected in the facilities of the world's nuclear industries and in transit between their factories.

The risks of proliferation also can be increased by unexpected technological developments, such as a rapid application of the centrifuge or laser methods of enrichment, unexpected improvements in fuel reprocessing, unexpected progress in the molten-salt breeder and thorium cycle breeder, or the development of the fission-fusion method for generating electricity.*

Likewise, the likelihood of proliferation in the future would be increased by development of many national fuel reprocessing and fuel fabrication plants, but would be limited by the alternative establishment of a few regional, multinational nuclear fuel centers. The outcome of tensions toward nuclear independence versus nuclear interdependence will have a substantial effect in the future.

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* In this concept, a fusion reaction provides a large supply of cheap neutrons to drive a fission process and also to convert uranium-238 into plutonium, or thorium into uranium-233 for use as nuclear fuels.

IV. FACTORS AFFECTING PROLIFERATION OF NUCLEAR WEAPONS

To consider the role of the International Atomic Energy Agency in limiting proliferation, it is first pertinent to inquire what factors affect proliferation. There follows an overview discussion of these factors supported by further attention to the world market for nuclear power and the problems posed by peaceful nuclear explosives.

Factors affecting proliferation: an overview

Future prospects for proliferation of the ability to make, acquire and use nuclear weapons and terrorist devices depend upon access to nuclear materials and motivation to seek nuclear weapons. Also, as long as terrorism can function as it does, prospects of proliferation to non-national groups remain real and likewise are affected by access to nuclear materials and by each group's own balancing of the benefits versus cost, effort, and risk of detection. Both horizontal and non-governmental proliferation are affected by the effectiveness of international agreements and organizations.

The principal factor affecting prospects for proliferation is that, like it or not, the nuclear genie is out of its bottle and is unlikely ever to return. Even were all nuclear materials now in human hands to be collected and dispersed back into nature in some irretrievable way and all nuclear facilities to be dismantled, many persons would still know how to produce nuclear materials and how to make nuclear weapons. Were all the world's nuclear scientists and engineers to be collected and confined, the public knowledge that fission is possible is all that other scientists and engineers need to know to rediscover the ways and means to make and use nuclear materials. So barring a collapse of modern technological civilization and descent into a new dark age wherein nuclear power might be forgotten, from this time on there can never be absolute assurance that somehow, somewhere a nation or subnational group that does not have nuclear weapons or terrorist devices will not get them. The best to be hoped for is that the likelihood of such proliferation can be kept acceptably small enough to assure stable future relations between nations and reasonable protection of the public health and safety.

The temptation and the ability of a nation or subnational group to acquire nuclear weapons and terrorist devices depends upon the amounts of nuclear materials produced and in use throughout the world, the number of facilities containing these materials, and their accessibility to clandestine operators and thieves or to sabotage. The more materials there are and the more places where they are produced, processed or used, the greater the potential accessibility for diversion or theft. Offsetting accessibility to some degree are measures for physical protection against diverters, thieves and saboteurs.

Targets for attempted diversion of theft include uranium-enrichment and plutonium production plants and associated laboratories, factories and storage depots. The chance of or theft from weapons production facilities seems less likely than from civil nuclear power facilities. However, some concern has been heard about risk of theft of U.S. weapons from overseas bases located in possibly unstable countries. For the future, the main source of nuclear materials for proliferation will be those places in the civil nuclear fuel cycle where highly enriched uranium, uranium-233 or plutonium are found. This accessibility will depend upon the growth of civil nuclear power throughout the world, particularly in those nations which do not now have atom bombs and which have not yet committed themselves to refrain from making them. Some of these nations have a well developed industrial base, others are developing nations that may wish to use nuclear energy for reasons of domestic economy or foreign relations.

Prospects for proliferation depend also upon access to nuclear science and technology. Given access to such information, a nation with modest financial and engineering resources can design, build and operate its own facilities to make plutonium. Virtually all of the information needed to make plutonium is available in published sources, although key technological information on design, construction and operation of uranium isotope separation plants is still held secret by national governments. Enough information is probably available from public sources about design and fabrication of nuclear weapons for a reasonably industrial nation to make them if it so chooses, and for subnational groups to attempt to make them if they can mount the necessary organizational effort and escape detection. Fortunately, nuclear weapons cannot be designed and built in a few days by the uninitiated.

Another factor likely to affect future proliferation is the civil or so-called "peaceful nuclear explosives" (PNE). The supply of PNE services by present weapons nations to non-weapons nations, even if under international supervision, could be used to mask further development of nuclear weapons, and so foster vertical proliferation. The development and production of PNE devices by non-weapons nations would make a shambles of present international commitments to forego nuclear weapons, and would severely if not fatally complicate international arrangements for the safeguarding of nuclear materials and facilities.

Factors affecting the motivation of nations to acquire nuclear weapons include both positive and negative, so the overall question facing the world community of nations is how to keep the balance between benefits and costs of proliferation unattractive to non-weapons governments. Non-weapons nations would be under strong pressure to proliferate, were their neighbors to do so, either for self protection or to achieve a perceived special advantage, even if short lived, for their foreign policy objectives. Offsetting pressures against proliferation would include the benefits of general limitation on the spread of nuclear weapons; unfavorable or hostile reaction by other nations to proliferation; the threat of possible sanctions; and the saving of scarce money and manpower for other assignments if national and international systems to prevent or to detect nuclear diversion and theft appear sufficiently effective.

In principle, factors likely to incline a non-national group toward proliferation would include the perceived publicity and terror value of a nuclear bomb or terror device for its goals. Offsetting this would be the ability of the group to invest the required time and effort, the risk of detection and intervention, the returns such a group could expect from assigning the required time and resources to other options, and the group's assessment of the effect of adverse world opinion upon attaining its goals.

While most terrorist groups probably need not fear a threat of nuclear reprisal, a world reaction that caused strong domestic and international anti-terrorist measures and compelled international cooperation in stamping out terrorist groups would be of concern to rational groups. Irrational groups probably would not have the patience to make nuclear weapons. There remains the possibility that criminal groups might steal materials, make weapons and offer them for sale. However, the prices they probably would demand would rule out most terrorist groups. Another possibility which no one likes to consider is that a nuclear weapons state might furnish such a group with nuclear weapons in the hope of creating unstable international relations that could be manipulated to its advantage. There is no way that measures to be discussed in this overview can protect against such a possibility.

The foregoing factors are affected by and interact with the effectiveness of international measures to deal with proliferation, notably the Non-Proliferation Treaty and international safeguards of the International Atomic Energy Agency.

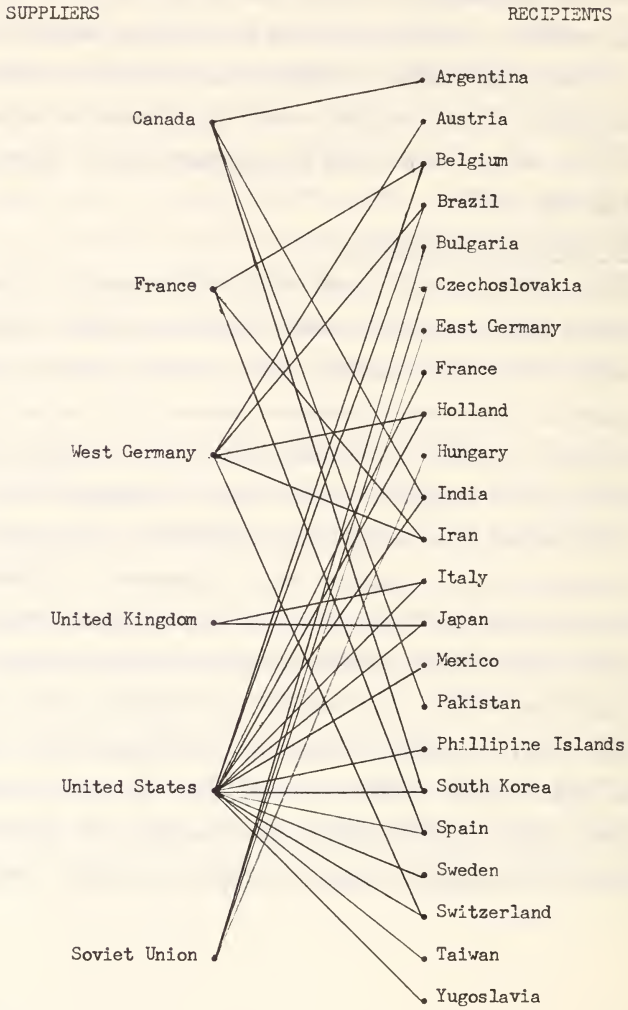
Overlaying all of these factors is the realization that measures to detect and to prevent proliferation and sabotage, to pursue and recover stolen nuclear materials are human activities and are thereby limited by human fallibility. Limited likewise are activities of governments or non-government groups which might seek to acquire nuclear weapons or terror devices. Once plutonium or uranium-233 or uranium highly enriched in the isotope 235 have been produced, there is no way to guarantee absolutely that they will not be diverted or stolen for nuclear weapons except to consume them in a nuclear chain reaction or to disperse them into nature. So in a nuclear world, the most that national and international efforts can accomplish with foreseeable actions is to delay the pace of proliferation, and to make it expensive or troublesome enough to dissuade nations or groups that have not yet decided upon a nuclear weapons effort. Any industrial nation which wishes to make nuclear weapons can do so without external aid so long as it can get uranium ores.

The world market for nuclear power

The prospects for further proliferation will increase if nations now buying nuclear powerplants on the world market also begin to acquire the plants, equipment and technology to produce nuclear materials suitable for use in weapons by reprocessing irradiated nuclear fuels or by enriching normal uranium. The sales of nuclear powerplants to a nation could be a precursor of sale of nuclear fuel cycle plant and equipment if the future trend of world nuclear power evolves toward unrestricted competition among nuclear suppliers and toward national energy independence. At present five major nuclear nations--the United States, the United Kingdom, France, West Germany, and Canada--are the world suppliers to developing nations. Italy, Japan, Sweden and perhaps India could become suppliers. The importing nations vary widely in industrial capability and include such nations as Argentina, Brazil, Spain, OPEC members, India, Pakistan, Taiwan, and South Korea. Within the Soviet sphere, there has been some flow of nuclear powerplants to nations such as Bulgaria and Czechoslovakia. However, the

Figure 1

MAJOR SUPPLIERS OF NUCLEAR POWERPLANTS
AND RECIPIENT COUNTRIES



Source: Information placed in the Congressional Record by Senator Symington June 3, 1975, p. S9324 (daily edition).

Soviet Union to date has exported nuclear powerplants outside of its sphere only to its neighbor, Finland. (Figure 1 shows the flow of exports of nuclear powerplants.) So in a real sense, the present and future problems of proliferation appear to originate mainly with the nuclear supplier nations of the free world.

Without doubt, the potential for proliferation depends upon the kinds of plant and equipment and technology present in international nuclear trade. If fuel reprocessing and enrichment capabilities can be bought on the world market, then the probability of proliferation will increase. If, however, supplier nations refrain from such exports, then it will be more difficult for nations using nuclear power to acquire the additional industrial base for quick production of nuclear weapons. Also, the more nuclear material readily usable in weapons flows in international commerce, the greater the probability of theft.

How rapidly nuclear power will grow throughout the world is a question with many sometimes contradictory answers. The International Atomic Energy Agency anticipates substantial increases based upon information from its member nations. On the other hand, some observers believe the high capital costs, lack of reliability, risk of accident and of diversion or theft of nuclear materials will combine to slow down, perhaps stop the growth of nuclear power. Some critics of nuclear power would impose a moratorium on further use. To the extent that nuclear power does not expand as forecast, the risks of proliferation are lessened. Prudence, however, requires a discussion of proliferation to consider the optimistic forecasts, for if realized these will have the greatest effect.

There follows a summary and some discussion of three recent forecasts of world nuclear power by: Dr. Theodore B. Taylor, a consultant to the Committee on Government Operations; the International Atomic Energy Agency; and Barber Associates.

The Taylor estimate.--Dr. Taylor provided a short-range forecast to the Committee on Government Operations. He noted that in 1974, 20 nations had operating nuclear power reactors, and 15 more had research reactors fueled with highly enriched uranium or able to annually produce enough plutonium for at least one fission explosive. By 1980 he expects the number of nations in these categories to exceed 45. Of the various types of nuclear power reactors, light-water moderated and cooled reactors fueled with slightly enriched uranium-235 (2-4%) accounted for 80 percent of the world's nuclear electricity capacity at the end of 1974. Most of the other capacity was provided by reactors fueled with natural uranium, either gas-cooled, graphite moderated as in the United Kingdom, or heavy water-cooled and moderated as in Canada. Some highly enriched uranium is used for fuel in high temperature, gas-cooled reactors, but only a few of these are expected to be operating by 1980. While fast breeder reactors can substantially increase the amount of plutonium generated per unit of electricity sent out, only a few experimental breeders are now in operation and few more are expected to be operable before the late 1980s. Until at least the mid-1980s, more than 95 percent of the world's nuclear power will come from reactors fueled with natural or slightly enriched uranium, some of which may be supplemented by recycled plutonium. So for the next decade, national and international measures to limit proliferation can be fitted to the technical characteristics of present type nuclear powerplants, with time to prepare additional or improved measures to deal with widespread use of plutonium in the late 1980s and beyond.

Table II presents Dr. Taylor's estimates, by country, of total installed nuclear power, annual net rates of plutonium production, and cumulative net quantities of plutonium produced at the end of the years 1974 and 1980. His estimates are based upon 1974 estimates of the IAEA. The conversion factors he uses to relate each 1000 megawatts of nuclear electrical generating capacity to plutonium production are listed in Table III and include an assumed factor of 0.7 between the average electric power output and the rated power output per plant.

A brief examination of Table II will give an idea of the magnitude of keeping fissionable materials out of irresponsible hands in the years ahead.

The IAEA estimates.--In 1973 the IAEA published a market survey for nuclear power in developing countries.* For 14 countries over the period 1980--1989, the survey projected total additional steam electric generating capacity of between 71,200 and 83,350 megawatts, of which 52,200 to 62,100 megawatts would be nuclear. Table IV gives the details. Note that for the first two years, less than 30 percent of the market would be supplied by nuclear plants; however, during the final five years, 80 percent or more of the market would be nuclear. As for the size of individual nuclear plants, the forecast shows little demand for small units of 400 megawatts or less,

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* International Atomic Energy Agency. Market survey for nuclear power in developing countries. General report. Vienna, September 1973, 61 p.

Table II.

Installed Nuclear Power and Plutonium Production, by Country, 1974 and 1980

Country	Installed Nuclear Electric Power, MW(e)		Rate of Plutonium Production (kg. per year)		Cumulative Plutonium Produced (kg.)	
	1974	1980	1974	1980	1974	1980
Argentina	320	920	59	340	59	1,100
Austria	--	690	--	160	--	720
Belgium	400	1,660	46	380	59	2,920
Brazil	--	600	--	140	--	620
Bulgaria	440	1,760	48	300	48	1,310
Canada	2,510	6,120	930	2,260	2,590	13,000
Czechoslovakia	110	1,770	41	370	82	1,090
Finland	--	1,540	--	350	--	1,130
France	2,870	15,170	1,100	3,750	4,880	18,000
Germany, F.R.	4,230	21,770	770	4,660	2,450	19,080
Germany, D.R.	440	1,760	100	410	100	1,920
Hungary	--	440	--	51	--	51
India	780	1,580	200	460	480	2,700
Ireland	--	600	--	69	--	69
Italy	610	3,390	180	820	1,740	4,530
Japan	5,020	18,400	950	4,420	2,420	21,200
Korea	--	1,160	--	240	--	820
Mexico	--	1,310	--	300	--	900
Netherlands	530	530	120	120	220	950
Pakistan	130	130	46	46	87	360
Spain	1,070	8,550	340	1,950	1,070	8,240
Sweden	2,610	8,270	350	1,800	510	7,200
Switzerland	1,010	5,690	230	1,090	580	3,800
Taiwan	--	3,110	--	720	--	1,640
Thailand	--	500	--	69	--	69
USSR	3,510	10,010	810	2,300	5,200	17,900
United Kingdom	5,800	10,750	1,970	3,000	20,200	36,600
USA	40,460	137,800	7,430	18,400	18,300	93,600
Yugoslavia	--	1,400	--	240	--	240
South Africa	--	2,000	--	230	--	230
Totals	73,000	270,000	16,000	49,000	61,000	260,000
Totals less USA, USSR, UK and France	20,000	96,000	4,400	22,000	12,500	96,000

Table III.

Conversion Factors for Estimating Plutonium Production Rates in Reactors

Reactor Type	Conversion Factor Kilograms of Pu per year per 1000 MW(e)
Light water moderated and cooled (LWR), slightly enriched uranium fuel	230
Heavy water moderated and cooled (HWR), natural uranium fueled	370
Gas cooled, graphite moderated (GCR), natural uranium fueled	430

with the bulk of the demand about evenly divided between medium-sized plants of 600 megawatts and large plants in the range of 800 to 1,000 megawatts. Table V gives the details. The IAEA forecast represented a market of from $22 billion to $26 billion (in 1973 dollars) for all steam electric powerplants for the ten years, 1980-1989, including from $1.3 billion to $1.5 billion for fuel cycle investment. Table VI gives the details.

TABLE IV. DISTRIBUTION OF POTENTIAL MARKET FOR NUCLEAR PLANTS BY SIZES OF PLANTS

Year	Low load forecast			High load forecast		
	Small 200-400 MW	Medium 600 MW	Large 800-1 000 MW	Small 200-400 MW	Medium 600 MW	Large 800-1 000 MW
1980	-	600	-	-	600	-
1981	-	1 200	-	-	1 200	-
1982	400	1 800	-	400	2 400	-
1983	400	3 000	800	400	2 400	1 600
1984	1 100	3 600	800	1 100	3 000	1 600
1985	700	1 800	3 200	700	1 800	3 200
1986	300	3 600	4 000	300	4 800	5 600
1987	-	2 400	3 400	-	3 600	4 200
1988	-	3 600	5 400	-	4 200	6 200
1989	300	3 000	6 800	600	3 600	8 600
Total	3 200	24 600	24 400	3 500	27 600	31 000
% of total	6.1	47.1	46.8	5.6	44.4	50.0

Source: IAEA. Market Survey for Nuclear Power in Developing Countries. 1973. p. 6.

TABLE V. FINANCING REQUIREMENTS, BY COUNTRY FOR ALL THERMAL PLANTS TO BE COMMISSIONED DURING 1980 - 1989 ($ million)

Country	Plant investment		Nuclear fuel cycle investment	Total
	Domestic	Foreign		
Argentina	1 068	1 047	144	2 259
Bangladesh-L	76	320	0	396
Bangladesh-H	187	919	17	1 123
Chile	191	548	41	780
Egypt	378	1 133	117	1 628
Greece	501	1 141	122	1 764
Jamaica-L	44	262	0	306
Jamaica-H	77	443	10	530
Korea	1 222	1 818	239	3 279
Mexico	2 859	2 642	348	5 849
Pakistan	125	421	17	563
Philippines	370	1 032	92	1 494
Singapore-L	121	295	0	416
Singapore-H	289	946	69	1 304
Thailand	341	802	76	1 219
Turkey-L	302	762	34	1 098
Turkey-H	394	1 289	86	1 769
Yugoslavia-L	860	805	111	1 776
Yugoslavia-H	1 466	1 440	211	3 117
Total low forecast (L)	8 458	13 028	1 341	22 827
Total high forecast (H)	9 468	15 621	1 589	26 678

Source: IAEA Market Survey for Nuclear Power in Developing Countries. 1973. p. 7.

TABLE VI. PROJECTED ANNUAL NUCLEAR PLANT ADDITIONS BY COUNTRY [a,b] (MW)

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total nuclear additions	Total thermal market	Nuclear % of total market
Argentina [c]	600			600	2 x 600		800	800	1000	1000	6000	6800	88.2
Bangladesh-L												1300	0
Bangladesh-H										600	600	3850	15.6
Chile					300	300	300			300	1200	1750	68.6
Egypt				600		600	600	600	2 x 600	600	4200	4800	87.5
Greece			400	400	400	600	600	600	600	600	4200	4500	93.3
Jamaica-L												1000	0
Jamaica-H										300	300	1550	19.3
Republic of Korea		600	600	600	2 x 600	600	2 x 600	2 x 600	600+ 800	600+ 800	8800	9100	96.7
Mexico		600	600 [d]	600+ 800	800	3 x 800	3 x 800	1000	2 x 800 1000	3 x 1000	14800	19600	75.6
Pakistan							600				600	2000	30.0
Philippines			600		600		800	800		1000	3800	5400	70.3
Singapore-L												2100	0
Singapore-H							600	600	600	800	2600	4700	55.3
Thailand					400	400	600		600	600	2600	3850	67.5
Turkey-L									600	600	1200	3000	40.0
Turkey-H							600	600	600+ 800	600	3200	4850	66.0
Yugoslavia-L				600	600	800		800	1000	1000	4800	6000	80.0
Yugoslavia-H			600	800	800	800	2 x 800	2 x 800	1000	2 x 1000	9200	10600	86.8
Total nuclear (L)	600	1200	2200	4200	5500	5700	7900	5800	9000	10100	52200	71200	73.3
Total nuclear (H)	600	1200	2800	4400	5700	5700	10700	7800	10400	12800	62100	83350	74.5
Nuclear % of total thermal (L)	13.5	26.4	44.0	73.7	75.3	86.4	86.3	78.4	87.3	94.8			
Nuclear % of total thermal (H)	12.5	24.0	51.9	70.4	68.3	83.2	89.9	83.0	88.9	98.5			

[a] Under reference conditions.

[b] L = Market Survey low load forecast; H = country high load forecast.

[c] Markets for countries with one load forecast are included in both low and high load totals.

[d] Actual capacity = 670 MW in country studies.

Source: Market Survey for Nuclear Power in Developing Countries. 1973. p. 5

More recently, in 1975, the IAEA published a forecast for world nuclear power through 1985.* According to information from member states, the International Agency projected an increase from about 200 nuclear power installations in 1975 to about 800 by 1985 with an accompanying increase in industrial facilities of the nuclear fuel cycle, as shown in Table VII. If the Agency's information is correct, a world nuclear capacity of some 700,000 megawatts of nuclear generating capacity would produce by 1985 a cumulative plutonium inventory of about 675 metric tons, with the inventory on hand in the reactors in 1985 estimated at about 520 metric tons. Since the IAEA

Table VII. Projected Facilities in the World Nuclear Fuel Cycle

Type of Facility	1975	1977	1980	1985
Power Reactors	200	280	420	800
Uranium Fuel Fabrication Plants	24	28	36	55
Uranium and Plutonium Mixed Oxide Fuel Fabrication Plants	21	23	26	30
Irradiated Fuel Reprocessing Plants	6	8	12	17
Enrichment Facilities	8	9	10	13

Source: International Atomic Energy Agency Bulletin, April 1975, p. 9.

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* Nuclear power growth and safeguards 1975-1985. International Atomic Energy Agency Bulletin, vol. 17, April 1975, pp. 7-12.

estimate assumes some of this plutonium will be produced by breeders, the forecast clearly anticipates plutonium recovery and use as fuel will be a reality ten years from now with its attendant proliferation implications.

The AEC estimates.--In February 1974, the Atomic Energy Commission published its forecast of nuclear power growth through the year 2000.* In its analysis, the AEC prepared forecasts for three cases. By the end of 1980, it expected the total nuclear capacity in other countries to be between 113,000 and 157,000 megawatts, and to increase to between 1,600,000 and 2,550,000 megawatts by the year 2000. These forecasts covered 30 major foreign nations including the Soviet Union and China.

Case X assumed a slower growth of demand for electricity. Case Y was the medium case which assumed an unchanged growth of demand for electricity. Case Z, which produced the highest forecast, assumed shifts from other energy sources to electricity and greater demand for nuclear power. Details of the AEC s forecast appear in Table VIII.

The Barber report.--In 1973 the Atomic Energy Commission contracted with Richard J. Barber Associates, Inc., to evaluate and estimate the potential market for products of the U.S. nuclear industry in the lesser developed countries, and to analyze the political, economic and security implications of U.S. nuclear technology exports to these countries. The

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* U.S. Atomic Energy Commission. Nuclear power growth 1974-2000. Feburary 1974, report WASH-1139 (74), 74 p.

Table VIII

FORCASTS OF FOREIGN NUCLEAR CAPACITY*

(Thousands of Electrical Megawatts)

Calendar Year	Case X		Case Y		Case Z	
	Additions	Cumulated	Additions	Cumulated	Additions	Cumulated
1974	3.2	26.7	10.1	33.6	10.1	34.8
1975	11.7	38.4	11.1	44.7	11.7	46.6
1976	8.6	46.9	9.9	54.6	15.4	62.0
1977	15.4	62.3	20.5	75.2	19.8	81.8
1978	18.4	80.7	19.2	94.3	17.4	99.2
1979	17.1	97.8	13.8	108.0	25.2	124.4
1980	14.8	112.6	32.3	140.3	33.0	157.4
1981	30.7	143.2	41.2	181.5	46.5	203.9
1982	40.	183.	44.	226.	45.	249.
1983	41.	224.	55.	281.	50.	299.
1984	30.	254.	53.	333.	56.	355.
1985	36.	290.	53.	387.	65.	420.
1986	50.	340.	57.	444.	76.	496.
1987	60.	400.	72.	516.	85.	581.
1988	70.	470.	79.	595.	97.	678.
1989	85.	555.	87.	682.	107.	785.
1990	85.	640.	98.	780.	115.	900.
1991	85.	725.	96.	876.	120.	1020.
1992	85.	810.	110.	986.	130.	1150.
1993	90.	900.	116.	1102.	140.	1290.
1994	90.	990.	126.	1228.	150.	1440.
1995	90.	1080.	138.	1367.	160.	1600.
1996	95.	1175.	140.	1506.	170.	1770.
1997	100.	1275.	150.	1657.	180.	1950.
1998	106.	1380.	156.	1812.	191.	2140.
1999	110.	1490.	153.	1965.	200.	2340.
2000	110.	1600.	165.	2130.	210.	2550.

* Rounding anomalies and plant retirements affect cumulated data.

Source: U. S. Atomic Energy Commission. Nuclear Power Growth 1974-2000. WASH - 1139 (74), p. 20.

report of this study was released by the Energy Research and Development Administration during 1975.*

The Barber report challenged the estimates of the IAEA and the AEC as inconclusive, but did not provide any substitute estimates. It said:

> It thus must be concluded that both the AEC and IAEA projections leave a great deal to be desired both in terms of the way they treat the issues they choose to address as well as with respect to those questions that though highly relevant have not yet been dealt with in any manner...

and further,

> Considered in this light, market projections of the type generated by AEC or IAEA are hardly conclusive. In the absence of more refined efforts similar to those suggested here, extant studies of future energy and electrical consumption levels represent a flawed basis from which to generate forecasts for the nuclear power market.**

From its viewpoint, effective forecasting of the nuclear power market for developing countries requires far more in the way of intensive, disaggregated, country-by-country economic and power consumption analysis than has been customary to date.***

So the net effect of the Barber report is to cast doubt upon IAEA and AEC projections and to indicate that greatly improved methods and data bases are needed for reliable projections, but not to provide revised market estimates.

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* Richard J. Barber Associates, Inc. LDC nuclear power prospects, 1975-1990: Commercial, economic and security implications. Washington, D.C., 1975, various pagings. Report no. ERDA-52.

** _Ibid._, pp. I-49, I-50.

*** _Ibid._, p. ix.

The problem of peaceful nuclear explosives

An avenue still open for some nations to openly acquire the ability to make nuclear weapons while asserting they are engaged only in peaceful uses of nuclear energy is the development and use of so-called peaceful nuclear explosions (PNE's). This road is closed to non-weapons nations that have ratified and adhere to the Treaty on Non Proliferation of Nuclear Weapons. It is open to nations that have not ratified the NPT. Through the NPT, the nuclear weapons nations are committed to supply non-weapons members with PNE services. The non-weapons nations in return are agreed not to develop such devices. A further complication is that development and testing of PNE devices could be used by NPT weapons states to conceal development of new or improved nuclear weapons. If and when PNE services are provided, they would be under special IAEA safeguards.

The situation today.--Peaceful nuclear explosives are not now in use. The Soviet Union, the United States and India all have detonated PNE devices. The Soviet Union continues to favor their use for grandiose civil engineering projects, while the NPT review conference of May 1975 reaffirmed the obligations of NPT weapons states to take appropriate measures to ensure that potential benefits from any peaceful applications of nuclear explosions are made available to non-weapons states. The conference noted too that any such benefits could be made available to non-nuclear weapons states not party to the Treaty by nuclear-weapons states under international observation and procedures. The conference also considered it imperative that access to potential benefits of nuclear explosions for peaceful purposes not lead to any proliferation of nuclear explosive capability.

Many questions remain to be resolved regarding the feasibility and practicability of peaceful nuclear explosions. To date no request for such explosions has ever gone beyond the stage of preliminary feasibility studies. So there has been no practical necessity to conclude the international agreement mentioned in NPT Article V. However, as Dr. Fred C. Ikle, Director of the U.S. Arms Control and Disarmament Agency, pointed out at the NPT review conference, the United States stands ready to negotiate the requisite agreements when the practical need develops. In the meantime, the United States is prepared to participate in consideration of the institutional arrangements that may be required to make the benefits of peaceful nuclear explosions available internationally. The United States has agreed as a potential supplier of such services to assist the Agency in a study of related legal problems.

The U.S. research and development program for PNEs has been declining for several years.

As for the world scene, of 40 United Nations members that have not ratified the NPT, ten probably have a strong enough industrial base to permit them to develop PNE devices if they chose to.* In addition, Taiwan, which has substantial industrial capabilities and interests in nuclear power, could present an unusual problem. Taiwan has been ejected from both the United Nations and the International Atomic Energy Agency to make way for the People's Republic of China.

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* The list of such nations includes: Argentina, Byelorussia, Chile, China, India, Israel, Portugal, South Africa, Spain and the Ukraine.

The IAEA and peaceful nuclear explosions.--Since 1968 the International Agency has been preparing for the use of peaceful nuclear explosives. In 1968 the United Nations Conference on Non Nuclear Weapons States recommended that the Agency initiate the necessary studies in the peaceful nuclear explosions field. Subsequently, the Agency took the following steps.*

1. The exchange of scientific and technical information has been facilitated by circulating information on the status of the technology and through the Agency's International Nuclear Information System. A bibliography of PNE-related literature was published in 1970.

2. In 1972, guidelines for "the international observation of PNE under the provisions of NPT and analagous provisions in other international agreements" were developed and approved by the Board of Governors. These guidelines defined the basic purpose of international observation as being to verify that in the course of conducting PNE projects the intent and letter of Articles I and II of the NPT are not violated.

3. In 1974, an advisory group developed procedures for the Agency to use in responding to requests for PNE-related services. These procedures have also been approved by the Board of Governors.

4. The Agency convened a series of technical meetings which reviewed the "state of the art." These meetings were convened in 1970, 1971, 1972 and in January 1975.

In January 1975 the Agency established a unit in the Secretariat to handle all requests for PNE services, to promote the exchange of information on this technology and to undertake or arrange feasibility, safety, economic and other relevant studies. The Agency's Board of Governors considered the use of PNE in February and June 1975, and on the latter occasion established an Ad Hoc Advisory Group on Nuclear Explosions for

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* International Atomic Energy Agency Bulletin, vol. 17, April 1975, p. 53.

Peaceful Purposes. The group reports to the Board and is open to participation by all interested Members. It also will deal with all aspects of PNE within the Agency's competence, such as procedures for handling requests, legal aspects and treaty obligations, health and safety matters, and economic aspects, including comparisons with non-nuclear alternatives. It will advise the Board on the question of an international service for PNE as well as on the structure and contents of the agreements that will be necessary under Article V of the NPT.

The NPT and peaceful nuclear explosions.--The NPT commits the nuclear weapons states not to supply nuclear weapons or other nuclear explosive devices to non-weapons states. The treaty also commits non-weapons states not to receive, manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, and not to seek or receive any assistance in their manufacture.* In return for this commitment by non-weapons states, the Treaty commits each party (which includes the United States) to take appropriate measures to ensure that, under appropriate international observation and through appropriate international procedures, potential benefits from any peaceful application of nuclear explosions will be made available to non-weapons NPT states on a non-discriminatory basis. The charge to such parties is to be as low as possible and is to exclude any charge for research and development. Non-weapons NPT states are to be able to obtain such benefits via a special international agreement or agreements, through an appropriate international body with adequate representation of non-nuclear-weapons states. Negotiations on this subject were to begin as soon as possible after the treaty entered into force on March 5, 1970. Also non-weapons NPT states may obtain such benefits via bilateral agreements.

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* U.S. Congress. House. Committee on Interior and Insular Affairs. Oversight hearings on nuclear energy--overview of the major issues. 94th Cong., 1st sess., 1975, p. 731.

The utility of civil nuclear explosions was questioned in September 1974 at an informal conference in Divonne, France, called to consider the problems likely to confront the NPT review conference.* One conclusion was that the benefits of peaceful nuclear explosions are questionable. The conference recommended that a study should be commissioned by the Secretary General of the United Nations of all the implications of such programs and suggested a moratorium on further PNE tests should be imposed until such a study is completed.

How far the NPT commits the weapons states to go in developing and supplying PNE's is a matter of differing opinions. For example, Professor Panofsky of Stanford University, a notable nuclear physicist, thinks that the NPT has been misinterpreted by PNE proponents to constitute a positive mandate to expand the use of these devices. He agrees that the Treaty commits its Parties to share equitably the economic benefits of PNE s but does not see this as a positive obligation toward developing new uses for these devices.**

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* The meeting was jointly sponsored by the Arms Control Association and the Carnegie Endowment for International Peace.

** U.S. Congress. House. Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment Oversight Hearings on Nuclear Energy--Overview of the Issues. p. 731.

The comprehensive nuclear test ban treaty.--Since 1963 the achievement of a comprehensive nuclear test ban treaty has been a publicly quoted policy of the United States, provided a test ban can be adequately verified. However, it would appear most difficult, perhaps impossible, to design a comprehensive test ban which would not also prohibit PNE's. Nuclear weapons tests are conducted for several purposes which include:

(1) development of new military explosive devices,

(2) verification and proof testing of weapons from stockpiles, and

(3) tests to show the effect of nuclear weapons systems of military interest.

If the further development and testing of peaceful nuclear explosions is permitted, it is not clear how the treaty could be administered to distinguish between PNE tests and military tests, even were international observation and inspection of the devices and tests to be provided.

The civil uses of nuclear explosions.--The enormous energy released by a nuclear explosion quickly caught the fancy of many scientists and engineers who began to speculate about civil as well as military uses. Six frequently considered applications, none of which has reached the stage of practical use, include:

(1) retorting of oil shale *in situ* after having fractured underground deposits of nuclear explosives,

(2) creating underground storage cavities,

(3) stimulation of flow of natural gas bound in "tight" geological formations,

(4) fracturing of copper and other ores *in situ* for extraction by leaching,

(5) generation of electricity from heat released underground by a nuclear explosion, and

(6) excavation of large engineering projects such as canals and harbors.

For example, in March 1960 the Joint Committee on Atomic Energy held hearings on frontiers in atomic energy research in which nuclear explosive devices were considered. At these hearings, Dr. Gerald W. Johnson of the AEC s Lawrence Radiological Laboratory discussed possible use of nuclear explosives for excavation and forecast that with an aggressive development program, one could anticipate that in a relatively short time excavation costs with nuclear explosives would be much less than by conventional methods and that consideration could be given to accomplishment of projects hundreds of times larger than those which it was possible to consider heretofore. The excavation of a sea-level canal across central America, for example, could be accomplished in two years with nuclear explosives, in comparison with 10 to 12 years for conventional methods.

Over recent years the U.S. program for development of peaceful nuclear explosives has been reduced to $1.3 million in the budget request for fiscal year 1977.

V. THE IAEA: BACKGROUND

Consideration of the possible role of the International Atomic Energy Agency in limiting proliferation of nuclear weapons logically begins with a brief sketch of the agency, what it is and what it does. This is the purpose of Chapter V, which presents brief background information on the statutory basis, functions and organizations of the Agency, the funding of its activities and United States participation in that funding, and U.S. representation at the IAEA.*

Statutory base functions and organization

The IAEA was established on July 29, 1957, by an international statute to promote and provide some limited international regulation for nuclear power. The stated objective of the Agency is to:**

> ...accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purposes.

The statute authorizes six functions. Four deal with promoting peaceful uses of atomic energy and two with their control. One control function is to establish and administer safeguards, the other is to establish and in some cases to provide for the application of standards of safety. The safeguards function has been developed while the safety standards function remains rudimentary.*

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* The information is supplemented by the text of the recent report on the IAEA by the Comptroller General of the United States, which appears in Appendix I, and by excerpts from a report for the then House Committee on Foreign Affairs (now the Committee on International Relations.)

** Statute of the IAEA, Article II. The statute, however, does not define "military purpose."

Today the IAEA is an autonomous international organization within the family of the specialized agencies that have ties with the United Nations. It is not under UN direction or control. The IAEA reports annually to the UN General Assembly and, in some instances, to the Security Council and to the Economic and Social Council. It has concluded relationship agreements with five other specialized agencies of the United Nations. It is located in Vienna, Austria.**

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* Article III of the international statute authorizes the following functions:

Promotional: (1) To encourage and assist research on, and development and practical application of, atomic energy for peaceful uses throughout the world...(2) To make provision for materials, services, equipment and facilities for research on and development and practical application of, atomic energy for peaceful purposes, including the production of electric power...(3) To foster the exchange of scientific and technical information on peaceful uses of atomic energy; (4) To encourage the exchange and training of scientists and experts in the field of peaceful uses of atomic energy.

Regulatory or control: (1) To establish and administer safeguards and to apply safeguards upon request to any bilateral or multilateral arrangement or at the request of a state; (2) to establish or adopt, in consultation and, where appropriate, in collaboration with competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property, and to apply these standards to nuclear activities based on the Agency's assistance or upon request to operations under any bilateral or multilateral arrangement or at the request of a state.

In carrying out these functions, the IAEA is further authorized to acquire or establish any facilities, plant and equipment, useful in carrying out its functions.

** IAEA membership is open to any state, whether it is a Member of the United Nations or not, which deposits an instrument of acceptance of this statute after its membership has been approved by the General Conference, upon recommendation of the Board of Governors. An IAEA Member Nation can withdraw at any time by written notice.

The principal organs of the Agency include a General Conference, a Board of Governors and a Secretariat. The General Conference, with representatives from all Members, meets annually to debate general policy and to consider recommendations of the Board of Governors. The Board, composed of representatives from 34 countries, considers policy and recommends budgets and programs to the General Conference. The Agency itself is headed by a Director General who is appointed by the Board of Governors with the approval of the General Conference for a term of four years. The statute designates him as the chief administrative officer of the agency.*

The Agency is organized into five departments of which one deals with safeguards and inspections. Figure II is the Agency's organization chart as of June 30, 1975.

The IAEA is small in comparison with most agencies of the Federal Government. On June 30, 1975, the Secretariat had 1,244 employees, of whom 378 were in the professional and higher categories, 627 in a general service category and 239 in the maintenance and operating service category. The number of nationalities represented among that part of the staff subject to the geographical distribution requirements was 56 in

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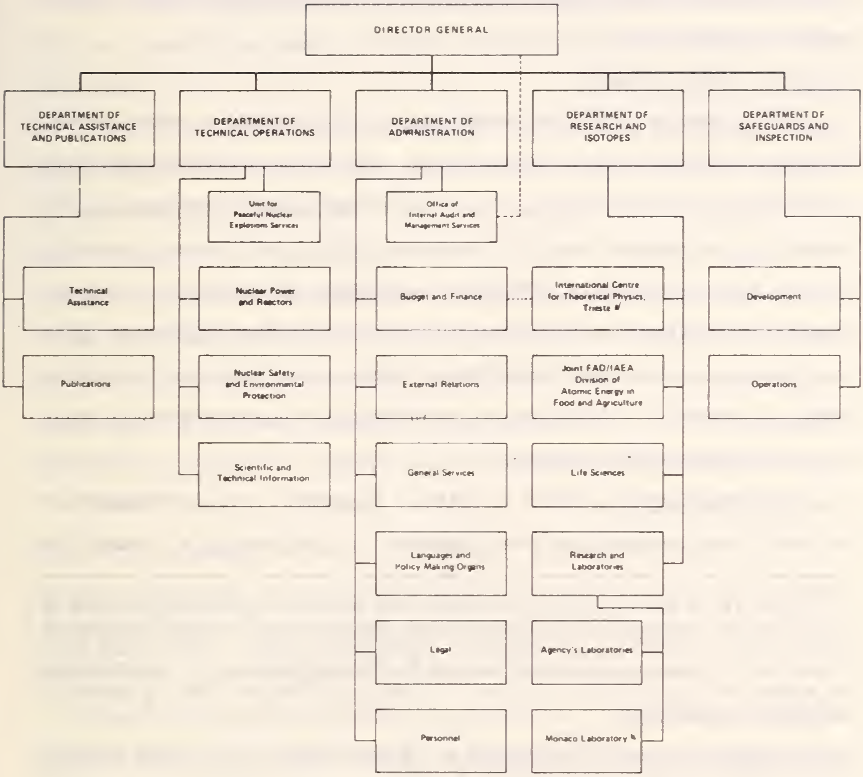
* The Director General is responsible for the appointment, organization and functioning of the staff and is under the authority of and subject to the control of the Board of Governors. He performs his duties in accordance with regulations adopted by the Board.

FIGURE II
ORGANIZATIONAL CHART


DIRECTOR GENERAL
DEPARTMENT OF TECHNICAL ASSISTANCE AND PUBLICATIONS
DEPARTMENT OF TECHNICAL OPERATIONS
DEPARTMENT OF ADMINISTRATION
DEPARTMENT OF RESEARCH AND ISOTOPES
DEPARTMENT OF SAFEGUARDS AND INSPECTION
Unit for Peaceful Nuclear Explosions Services
Office of Internal Audit and Management Services
Technical Assistance
Publications
Nuclear Power and Reactors
Nuclear Safety and Environmental Protection
Scientific and Technical Information
Budget and Finance
External Relations
General Services
Languages and Policy Making Organs
Legal
Personnel
International Centre for Theoretical Physics, Trieste a/
Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture
Life Sciences
Research and Laboratories
Agency's Laboratories
Monaco Laboratory b/
Development
Operations

Source: International Atomic Energy Agency. Annual Report, 1 July 1974 - 30 June 1975. (GC (XIX)/544) Vienna, 1975. p. 49.

comparison with 54 of the previous year.* ** According to the General Accounting Office, the United States supplies the largest number of IAEA professional personnel, filling 20 percent of the positions, subject to geographic selection.***

Funding of IAEA activities

IAEA activities are funded through assessed contributions and voluntary and special contributions of its members, with some income derived from sales of publications and charges for services and technical assistance. Expenditures for calendar year 1974 were about $29.3 million and were estimated at $35.5 million for 1975.**** In addition, the Agency receives assistance-in-kind from Members in the form of fellowships, equipment, supplies, special nuclear material, films, publications, experts, and other goods and services. It also receives assistance through contracts and other arrangements by Member Nations.

U.S. participation.--Since the IAEA's inception, U.S. participation in its funding has amounted to about one-third of the Agency's measurable resources. Through 1974, U.S. participation totaled about $76 million which included $54.2 million to the regular IAEA budget assessments, $10.7 million in voluntary contributions, $9.3 million in gifts-in-kind, $1.1 million in research contracts, and $0.7 million in gifts of special nuclear materials.

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* Article VII of the international statute sets out criteria for employment of staff. One criterion is technical competence and integrity, another is member contribution, a third is recruitment on a geographic basis. The statute specifies that "...due regard shall be paid to the contributions of members to the Agency and to the importance of recruiting staff on as wide a geographical basis as possible."

** International Atomic Energy Agency. Annual report, 1 July 1974-30 June 1975. 1975. Report GC (XIX)/544, p. 48.

*** U.S. Comptroller General. Role of the International Atomic Energy Agency in safeguarding nuclear material. Report to the House Committee on International Relations. July 3, 1975. Report no. ID-75-65, p. 2.

**** Ibid., p. 2. This section draws extensively upon the Comptroller General's analysis of U.S. financial participation.

The U.S. share of assessed contributions has been decreasing steadily since 1960. In 1972 Congress imposed a limit of 25 percent on assessments to international organizations. IAEA was exempt from this limitation, in part because of the undesirable effect reduced U.S. funding might have on safeguards. However, in keeping with congressional intent, the overall share of the U.S. assessment will be reduced from 31.9 percent ($7,382,611) in 1974 to 28.0 percent ($7,452,741) in 1975. The Comptroller General notes that U.S. officials hoped by 1978 to reduce the U.S. rate of assessed contributions on the non-safeguard part of the IAEA budget to 25 percent.

The U.S. share of voluntary and special contributions is somewhat more than for its regular assessed contributions, although this share also is expected to decrease. U.S. voluntary cash contributions in 1973, for example, amounted to about one-third of the total pledges by member nations and U.S. gifts-in-kind were estimated at 35 percent of all such contributions.

The United States has provided other types of support. The Comptroller General notes that since 1968, the U.S. Arms Control and Disarmament Agency has awarded about $3.3 million in contracts to U.S. firms for research on safeguards instrumentation and techniques based on needs identified by the IAEA.

U.S. representation at the IAEA

The United States maintains a small diplomatic mission to the IAEA which is headed by a U.S. representative with the rank of Ambassador. The present U.S. representative is Dr. Gerald Tape.* Usually the U.S. representative has remained in the United States, visiting the Mission and the Agency to take part in activities of the Board of Governors, the General Conference and on special occasions. A new deputy director, Mr. Galen L. Stone, will be resident in Vienna.** The mission staff includes professional personnel assigned from the Department of State and Energy Research and Development Administration. The Mission's function is to protect and foster U.S. interests in the IAEA by recommending policy positions, representing the United States at most non-scientific meetings, assisting the U.S. representative, and informing the Department of State, ERDA, and other U.S. agencies of developments within and concerning IAEA.***

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* Dr. Tape is president of Associated Universities, Inc., which operates the Brookhaven National Laboratory for ERDA. He was an AEC Commissioner for six years, 1963-1969.

** The Senate confirmed Mr. Stone's nomination on February 6, 1976.

*** U.S. Comptroller General, _op. cit._, p. 3.

VI. DETECTING DIVERSION OR THEFT OF NUCLEAR MATERIALS: IAEA SAFEGUARDS

The word "safeguards" was first used to describe measures to keep nuclear materials and equipment from furthering military purposes in the joint declaration of November 15, 1945, by the President of the United States and the Prime Ministers of Canada and the United Kingdom.* In their statement of policy for an atomic era, the three heads of state proposed the United Nations should set up a commission to make specific proposals on nuclear matters including safeguards to protect states complying with a ban on nuclear weapons from hazards of violations and evasions.**

The concept of nuclear safeguards soon appeared again in the United Nations General Assembly's first resolution in which it resolved to establish a United Nations Atomic Energy Commission to deal with the problems raised by the discovery of atomic energy and other related matters. The

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* Webster's New International Dictionary defines the noun safeguards to include the following: (1) A means of defense or protection, a guard; (2) A convoy, guard, or escort, to protect a traveler or property; a pass; a passport; a safe-conduct; a technical contrivance or device to prevent accident; a means of preventing some undesirable outcome or tendency. As a verb, safeguards means: to guard; to protect; to provide safeguards for; to serve as a protection.

** Cf., Richard G. Hewlett and Oscar E. Anderson, Jr. The new world, 1939/1946. Volume 1. A History of the United States Atomic Energy Commission. University Park, Pa.: The Pennsylvania State University Press, 1962, p. 465. The Joint Proposal called for the United Nations to set up a commission to make specific proposals for (a) extending between all nations the exchange of basic scientific information for peaceful ends, (b) controlling atomic energy to the extent necessary to ensure its use only for peaceful purposes, (c) eliminating from national armaments atomic weapons and all other major weapons adaptable to mass destruction, and (d) setting up safeguards to protect complying states from the hazards of violations and evasions.

UNAEC's terms of reference included, among others, making proposals for control to ensure only peaceful use of atomic energy, elimination of atomic weapons, and effective safeguards.

The United Nations resolution laid down several principles which continue to influence considerations of proliferation and nuclear disarmament to this day. The first stated principle was a recognition "that the fruits of scientific research should be made available to all nations and that freedom of investigation and free interchange of ideas are essential to the progress of knowledge." Another principle was commitment to the use of safeguards. The resolution emphasized "effective safeguards by way of inspections and other means to protect complying states against the hazards of violations and evasions." Another was that nuclear disarmament be accompanied by effective international safeguards.*

The U.S. proposals for international control of atomic energy.--The creation of the UNAEC provided the stage for a radical U.S. proposal for the international control of atomic energy to prevent proliferation of weapons. On June 14, 1946, Bernard M. Baruch, the United States Representative, presented the United States proposals to the Commission.*

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* Two years later in August 1948 the United Nations Commission for Conventional Armaments adopted a resolution of general principles on conventional disarmament which included an eloquent statement of the objectives of safeguards. The resolution stated that:

> A system for the regulation and reduction of armaments and armed forces must include an adequate system of safeguards, which by including an agreed system of international supervision will ensure the observance of the provisions of the treaty or convention by all parties thereto. A system of safeguard cannot be adequate unless it possesses the following characteristics:
> (a) It is technically feasible and practical;
> (b) It is capable of detecting promptly the occurrence of violations;
> (c) It causes the minimum interference with, and imposes the minimum burdens on, any aspect of the life of the individual nation.

The U S. approach to safeguards was substantially different than that of today for Baruch proposed that all nuclear materials and dangerous nuclear operations be under direct managerial control of an International Atomic Development Authority and not be in the hands of government or private bodies subject only to regulation by the Authority.

Many proposed measures of the U.S. plan remain relevant today, as is evident in the following excerpts from his speech:

> General. The Authority should set up a thorough plan for control of the field of atomic energy, through various forms of ownership, dominion, licenses, operation, inspection, research and management by competent personnel. After this is provided for, there should be as little interference as may be with the economic plans and the present private, corporate, and state relationships in the several countries involved.
>
> Primary production plants. The Authority should exercise complete managerial control of the production of fissionable materials. This means that it should control and operate all plants producing fissionable materials in dangerous quantities and must own and control the product of these plants.
>
> Atomic explosives. The Authority should be given sole and exclusive right to conduct research in the field of atomic explosives.

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* It was here that the United States proposed the creation of an International Atomic Development Authority to which would be entrusted all phases of the development and use of atomic energy, starting with the raw material and including: (1) managerial control or ownership of all atomic energy activities potentially dangerous to world security; (2) power to control, inspect, and license all other atomic activities; (3) the duty of fostering the beneficial uses of atomic energy; and (4) research and development responsibility...intended to put the Authority in the forefront of atomic knowledge and thus to enable it to comprehend, and therefore to detect, misuses of atomic energy.

> Operations of dangerous activities. Any plant dealing with uranium or thorium after it once reaches the potential of dangerous use must be not only subject to the most rigorous and competent inspection by the Authority, but actual operation shall be under the management, supervision, and control of the Authority.
>
> Inspection. By assigning intrinsically dangerous activities exclusively to the Authority, the difficulties of inspection are reduced.
>
> Freedom of access. Adequate ingress and egress for all qualified representatives of the Authority must be assured. Many of the inspection activities of the Authority should grow out of and be incidental to its other functions.

The Baruch proposals also called for penalties for violations of commitments not to make or possess atom bombs. They specified five categories of violations that would warrant immediate and certain penalties:

1. Illegal possession or use of an atomic bomb;
2. Illegal possession, or separation, of atomic materials suitable for use in an atomic bomb;
3. Seizure of any plant or other property belonging to or licensed by the Authority;
4. Willful interference with the activities of the Authority;
5. Creation or operation of dangerous projects in a manner contrary to, or in the absence of, a license granted by the international control body.

Such penalties, Baruch emphasized, could not be subject to the veto power of the United Nations Security Council.

The U.S. proposals were not adopted because of unresolved differences between the United States and the Soviet Union over timing of nuclear disarmament, inspection for verification, and the veto power of the Security

Council. Nonetheless, the proposals provide a benchmark for current consideration of measures to limit proliferation in the decades ahead.

The UNAEC recommendations on safeguards.--On the last day of December 1946, the United Nations Atomic Energy Commission submitted its first official report. In it the Commission called attention to the findings on safeguards of its Scientific and Technical Committee. The Committee considered safeguards for declared activities, safeguards to detect clandestine activities, safeguards against seizure, and coordination of safeguards.* These functions remain pertinent today.

Based upon the findings of its Scientific and Technical Committee, the UNAEC thirty years ago emphasized that an international control agency would require broad privileges of movement and inspection, including rights activities. Such rights were necessary because the detection of clandestine to conduct surveys by ground and air; and to ensure detection of clandestine nuclear weapons manufacture was deemed almost impossible, so it was vital that any unauthorized accumulation of nuclear materials be prevented.

The Commission itself came to two fundamental conclusions relating to safeguards. First, it appeared scientifically, technologically and practically feasible to control atomic energy to the extent necessary to ensure its use only for peaceful purposes and to provide effective safeguards by way of inspection and other means. Second, that effective control of atomic energy depends upon effective control of the production and use of uranium, thorium, and their fissionable derivatives. Appropriate mechanisms of control to prevent their unauthorized diversion or clandestine production and use and to reduce the dangers of seizure must be applied, said the UNAEC, through the various stages of the processes from the time the uranium and thorium ores are removed from the ground to the time they become nuclear fuel and are used. Appropriate mechanisms included one or more of the following types of safeguards: accounting, inspection, supervision, management and licensing.

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* The report on safeguards of the Scientific and Technical Committee from the UNAEC report appears in Appendix V.

For the UNAEC, an effective control system for atomic energy had to be international and had to be established by an enforceable multilateral treaty or convention administered and operated by an international agency with adequate powers, organization and resources. Of the specific need for international safeguards, the UNAEC concluded as follows:

> Only by such an international system of control and inspection can the development and use of atomic energy be freed from nationalistic rivalries with consequent risks to the safety of all peoples. Only by such a system can the benefits of widespread exchange of scientific knowledge and of the peaceful uses of atomic energy be assured. Only such a system of control and inspection would merit and enjoy the confidence of the people of all nations.

The UNAEC and the United Nations, as noted earlier, never did resolve differences between the United States and the Soviet Union. By the early 1950s both the Soviet Union and the United Kingdom had nuclear weapons and the United States was engaged in massive expansion of its production of fissionable material for military purposes. The time had gone for consideration of international ownership and managerial control

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* The International control of atomic energy. The first report of the United Nations Atomic Energy Commission to the Security Council. Washington, D.C.: U.S. Government Printing Office, 1947, p. 19.

of nuclear energy materials and facilities as the principal element of nuclear safeguards. Nonetheless, the views of the UNAEC and the safeguards discussions of its Scientific and Technical Committee take on fresh relevance to the present interest in safeguards and other measures to limit proliferation.

Safeguards for the IAEA

President Eisenhower's Atoms for Peace Plan of December 1953 hinted at a safeguards function of the proposed international atomic energy agency with its pool of nuclear materials. Soon the first sketches of the statute for the Agency included a right to apply safeguards and to verify the use of material allocated by the Agency to any state. The safeguards concept was to develop further in the negotiations but not to the point of committing nations which ratified the statute to put their nuclear activities under IAEA safeguards. This was to remain voluntary.

The Statute of the International Atomic Energy Agency was opened for signature in October 1956. One statutory function was for the IAEA to establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request, or under its supervision or control are not used in such a way as to further any military purposes. The Agency could also apply safeguards, upon request, to any bilateral or multilateral arrangement, or at the request of a state to any of that state's activities in atomic energy.*

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* Article III-5.

The IAEA's safeguards rights and responsibilities are specified in detail in Article XII which also authorizes the Agency to establish a staff of inspectors. As for Agency action in case of non-compliance or failure by a state to take requested corrective steps within a reasonable time, the statute authorizes the Agency to suspend or terminate its assistance and to withdraw any materials and equipment made available by the Agency or its member.

Briefly, the statutory rights and responsibilities of the IAEA for safeguards include examination and approval of the design of nuclear facilities, enforcement of health and safety measures, requirement of records and progress reports, approval of nuclear fuel reprocessing and inspection. The following excerpts from Article XII supply more detail.

> With respect to any Agency project, or other arrangement where the Agency is requested by the parties concerned to apply safeguards, the Agency shall have the following rights and responsibilities to the extent relevant to the project or arrangement:
>
> 1. To examine the design of specialized equipment and facilities, including nuclear reactors, and to approve it only from the viewpoint of assuring that it will not further any military purposes, that it complies with applicable health and safety standards, and that it will permit effective application of safeguards. . .
>
> 2. To require the observance of any health and safety measures prescribed by the Agency;
>
> 3. To require the maintenance and production of operating records to assist in ensuring accountability for source and special fissionable materials used or produced in the project or arrangement;
>
> 4. To call for and receive progress reports;
>
> 5. To approve the means to be used for the chemical processing of irradiated materials solely to ensure that this chemical processing will not lend itself to diversion of materials for military

> purposes and will comply with applicable health and safety standards...
>
> 6. To send into the territory of the recipient state or states inspectors, designated by the Agency, after consultation with the state or states concerned, who shall have access at all times to all places and data and to any person who by reason of his occupation deals with materials, equipment or facilities which are required by this statute to be safeguarded, as necessary to account for source and special fissionable materials supplied and fissionable products and to determine whether there is compliance with the undertaking against use in furtherance of any military purposes...Inspectors designated by the Agency shall be accompanied by representatives of the authorities of the state concerned, if that state so requests, provided that the inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

The inspectors are required by the statute to report any non-compliance to the Director General who is to transmit the report to the Board of Governors. The Board is to call upon the state or states involved to remedy any non-compliance which it finds to have occurred. The Board also is to report non-compliance to all IAEA members and to the Security Council and the General Assembly of the United Nations.

IAEA safeguards for non-NPT states: The INFCIRC 66 system

As seen by key officials, the IAEA statute, while it provides the basis for the Agency's safeguards, was never meant to be more than a framework for the system. The substance of the safeguards system is to be found in the agreements between the Agency and the states concerned.*

Although the IAEA was established in 1957, it was not until 1961 that the Agency's Board of Governors adopted the first safeguards system, which applied only to reactors with a thermal output of less than 100 megawatts. In 1964 the system was extended to larger reactors and a review was made. This resulted in 1965 in the adoption of the IAEA system now in use for nations that have not ratified the NPT. The system is generally referred to by the number of the information circular in which it was published, Information Circular number 66.

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* B. Sanders and R. Rometsch. Safeguards against use of nuclear material for weapons. Nuclear engineering international, v. 20, September 1975, p. 682.

All safeguards agreements concluded with non-NPT states incorporate this system. In 1966 the system was extended to include safeguards for fuel reprocessing plants and in 1968 provisions were added for safeguarding of materials in conversion and fuel fabrication plants. The complete document, including the two additions, is now referred to as INFCIRC/66/Rev. 2.* The text of this document appears in Appendix III.

The provisions of the circular 66 safeguards become binding only to the extent that they are incorporated in the individual safeguards agreements which may vary with the specific situations. So although there is a standardized system defined, how it is applied depends upon the negotiators.

Categories of safeguards agreements.--The main reasons for a state to enter into an IAEA safeguards agreement are either that it is party to an international instrument like the Non-Proliferation Treaty or the Treaty of Tlatelolco (Treaty for the Prohibition of Nuclear Weapons in Latin America) or to fulfill obligations it has accepted in order to obtain nuclear material, equipment, or technological know-how from another state. There are three categories of safeguards agreements between the IAEA and the non-NPT states: (1) "safeguards transfer agreements" in which parties to a bilateral agreement for nuclear cooperation transfer to the Agency the right and obligation to apply safeguards; (2) "unilateral submission agreements" by which a state submits all or part of its nuclear activities to Agency safeguards; (3) "project agreements" in which IAEA safeguards follow materials and assistance provided by the Agency. As of June 30, 1975, there were 56 such agreements in effect, 31 transfer agreements, 8 unilateral agreements, and 17 project agreements.

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* The Agency's safeguards system (1965, as provisionally extended in 1966 and 1968) IAEA information circular INFCIRC/66/Rev. 2, Sept. 16, 1968, 21 p.

According to IAEA officials, as the international nuclear trade increases and exporting states wish to make sure that their exports do not further any military purposes, the unilateral submission agreements are becoming more frequent.* Some exporting states are bound by the NPT which requires them not to provide nuclear items without safeguards. Other exporting states not party to the Treaty so far have made it policy to follow the same approach. This trend has made it necessary for the IAEA to seek more standardization in its circular 66 agreements, particularly for duration and termination provisions. Recently the IAEA Board of Governors formally adopted a policy that rights and obligations to apply safeguards should remain in force as long as supplied items or any special fissionable material produced in or by their use are in actual use in the state. The evolution of circular 66 safeguards is expected to continue. In the light of the tendency to require that the supply of certain important nuclear items or nuclear know-how should "trigger" safeguards, it may be expected that this document in the near future will undergo important changes.*

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* Sanders and Rometsch, op. cit., p. 683.

IAEA safeguards for NPT states: the INFCIRC 153 system

On July 1, 1968, the Treaty on the Non-Proliferation of Nuclear Weapons was opened for signature and immediately afterwards, the IAEA started to prepare for its new safeguards responsibilities under the treaty. Article III of the NPT commits each non-nuclear weapons state Party to the Treaty to accept IAEA safeguards for all of its peaceful activities for the "...exclusive purpose of verification of the fulfillment of its obligations...with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices." It also requires each state not to supply nuclear items to any non-nuclear weapons state for peaceful purposes unless the source or special fissionable material involved shall be subject to IAEA safeguards. The Agency is to implement the safeguards so as to avoid hampering the economic or technological development of the Parties, or international cooperation in peaceful nuclear energy. Non-nuclear weapons states party to the Treaty also had to negotiate agreements with the Agency within 18 months of the start of negotiations.

The Agency at once convened consultations to analyze the way in which it should apply safeguards for a country's whole range of peaceful nuclear activities to ensure that such safeguards would be effective, economic and widely acceptable.

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* Ibid.

The Treaty entered into force on March 5, 1970. Immediately thereafter the IAEA Board of Governors established a committee to advise it on the agreements which would be required between the Agency and NPT nations. The Committee produced recommendations and the draft of a complete safeguards system for NPT safeguards. On April 20, 1971, the Board authorized the Director General to use this material as the basis for negotiating agreements required by Article III of the NPT. This safeguards system likewise is known by the number of its IAEA information circular, INFCIRC/153.* It is referred to as the "Blue Book" because of the color of its cover. The text of circular 153 appears in Appendix IV.

At the time the NPT entered into force, the Agency had safeguards agreements with 32 states. Subsequently 25 of these were suspended as the states involved concluded agreements for replacement NPT safeguards. The circular 153 system has formed the substance of every NPT safeguards agreement so far concluded, although here too some important development has taken place which is described below in the discussion on the role of state safeguards systems. At the end of 1975, the Agency had 45 NPT-type agreements in force and 40 non-NPT-types.

The non-NPT safeguards system and the NPT system differ fundamentally in their stated purpose. The former is intended to assure that assistance provided by the Agency, or at its request or under its supervision or control is not used in such a way as to "further any military purpose." The latter is intended to assure timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown. Non-NPT safeguards apply only to specific nuclear materials and facilities while NPT safeguards apply to all nuclear materials and facilities for peaceful purposes in a state. The non-NPT system set out no technical objectives for safeguards nor did it specify what conclusions were to be drawn from verification activities. The NPT agreements provided that the technical conclusion of the Agency's verification activities should be a statement, in respect of each materials balance area, of the amount of material unaccounted for over a specific period, giving limits of accuracy of the amounts stated. Thus NPT safeguards were directed toward obtaining quantitative statistics that leave room for reasonable judgment.*

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* The structure and content of agreements between the Agency and states required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons. IAEA information circular INFCIRC/153, May 1971, 29 p.

The inclusion of the phrase "or for purposes unknown" in the stated objectives of NPT safeguards is seen as of great importance for the practical application of safeguards. For the IAEA, this expression means that the safeguards inspectorate does not have to prove that a specific explosive device has been manufactured, an almost impossible task in practice. Rather, it need only establish proof for the presence or consumption of the nuclear materials in peaceful activities. The disappearance of nuclear materials in an NPT safeguards system in itself is considered to constitute diversion.**

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* Sanders and Rometsch, _op_. _cit_., p. 683.

** _Ibid_.

Relationship of IAEA and state safeguards

The safeguards systems for NPT and for non-NPT states differ significantly. Each non-NPT state under the circular 66 system is required to keep records and make reports with respect to principal nuclear facilities and for all safeguarded nuclear material outside such facilities, but is not obligated to inform the IAEA about nuclear facilities or materials not covered by the agreement. Each NPT state under the circular 153 system is expected to establish a national system of accounting and control for all nuclear materials covered by the Treaty and the IAEA is expected to make full use of the state system to avoid unnecessary duplication. The interaction of IAEA and the state is further indicated by the provision in circular 153 that the Agency is to carry out its NPT safeguards system in a manner designed to:

(1) Avoid hampering the economic and technological development of the state or international cooperation in the field of peaceful nuclear activities, including international exchange of nuclear material.

(2) Avoid undue interference in the state's peaceful nuclear activities, and in particular in the operation of facilities; and

(3) Be consistent with prudent management practices required for the economic and safe conduct of nuclear activities.

The Agency's verification, however, is to include independent measurement and observations.

The NPT safeguards system generally does not provide for coordination of IAEA and state safeguards activities, nor are criteria established for state systems. Each state has many possibilities in establishing its accounting and control system. One is merely to regulate the accountancy procedures of the facility operators and use their accounts as those of the state. Another is to establish a national nuclear material accountancy system, including verification of operators' accountancy by independent measurements. The choice is up to the government involved.

The Agency appears to prefer an independent national system which would materially assist the IAEA in its work and reduce IAEA verification activity. So it becomes important for the IAEA to work out details of coordination between the verifications of Agency and state. This was done for the first time in connection with the agreement between the European Atomic Energy Community (EURATOM), its non-weapons member states, and the IAEA. Here the existing EURATOM safeguards system has taken over the role of accountancy and control for its member states. The coordination arrangement between the EURATOM inspectorates is provided for in the safeguards agreement between these two international agencies. Recently a similar coordination arrangement was negotiated by the Agency with Japan where the national system is expected to provide for intensive verification. The other NPT safeguards agreements covering significant nuclear activities are carried out with the help of states' systems of various sophistication, none of which, however, includes independent verification.*

Access to IAEA safeguards documents

Public access to key documents for IAEA safeguards systems is limited and not uniform. For the non-NPT system under circular 66, the basic documents consist of the circular itself, which is available to the public, and the text of the agreement, which usually is published as an Agency information circular. The specific materials or facilities to be safeguarded are listed in an inventory supplied by the safeguarded state. This inventory is not a public document. For the NPT system under circular 153, several documents are involved. A typical agreement, with the German Democratic Republic, appears in Appendix VI. These agreements are general, with no information on the specific facilities or materials to be covered. Information on such items is assigned to a Subsidiary Arrangement which may be changed or extended by mutual agreement without amendment of the safeguards agreement itself. The Subsidiary Arrangements usually consist of a general part applicable to all peaceful nuclear activities in the state and a separate Facility Attachment for each facility and each material balance area outside the facilities. Supplementing these documents is a list of facilities and material balance areas. The supplementary documents indicate the material balance areas to be used for Agency accounting purposes and specifying, for each category of facility, the maximum inspection effort rights of the Agency. The contents of a typical Subsidiary Arrangement appear in Table IX. The outline for a typical Facility Attachment appears in Appendix VII. At present only the safeguards agreement document is available to the public. The Subsidiary Arrangements and the Facility Attachments and supplementary lists are all held secret by the Agency.

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* Ibid., p. 684.

Safeguards implementation

The IAEA's safeguards systems depend on two elements: (1) the maintenance and review of records showing the receipt, production, consumption,

Table IX.

TYPICAL TABLE OF CONTENTS FOR AN IAEA SUBSIDIARY ARRANGEMENT FOR NPT SAGEGUARDS

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1. Regular channels of communication
   - Communications from Agency
   - Communications from [..........]
2. National system of accounting for and control of nuclear material
   - Measures foreseen in the Agreement
   - Specifications of information to be provided; and information provided by [..........]
3. Provision of information by [..........]
   - Information on facilities and on nuclear material outside facilities
   - Radiological protection
   - Initial report
   - Accounting reports
   - Special reports
   - Information on international transfers
4. Provision of information by the Agency
   - Agency statements
   - Information on inspections
5. Publication of information by the Agency
6. Termination of, exemption from and reapplication of safeguards Model proposal for termination
   - Model request for exemption
   - Model communication on re-application of safeguards
7. Advance notifications of international transfers
   - Model notification of intended export
   - Model notification of expected import
8. Model inventory for [..........] of nuclear material subject to safeguards
   - Agency statements of book inventory of nuclear material for[..........]
   - Model export account for [..........]
9. Inspections and inspectors
   - Model inspection assignment
   - Authority granting and renewing inspectors' visas
   - Periodic inspection program
   - Arrangement for samples (sampling certificate)
10. Repeat forms and explanations for their use

transfer, and storage of nuclear materials and (2) inspections.* For both the NPT and non-NPT state safeguards, the IAEA safeguards consider the following items:

--A review of the design of nuclear facilities.

--A review of the facilities' material records and reports.

--Inspection and surveillance of the facilities.

A basic step in implementing safeguards after the underlying agreements are concluded is IAEA review of the design of the facilities involved. This enables IAEA to determine the character, purpose, capacity and layout of the facility. After consulting the state, the IAEA selects those surveillance techniques and containment devices such as cameras and seals, if any, to be used; selects key points for measuring materials flows and inventories; and establishes requirements for records and reports. The decisions reached on what safeguards will be applied at individual facilities are reflected in the various Facility Attachment documents which also contain information on the number, scope and mode of inspections. Generally, inspection access is more specifically defined and limited in NPT safeguards agreements than in the non-NPT agreements.

The IAEA recently has prepared Safeguards Implementation Practices (SIP) documents for each safeguarded facility. These documents, which are kept secret by the Agency, establish the safeguards approach for a given facility. Each is intended to provide an in-depth analysis of existing conditions at a facility that may affect the task of the inspectorate. It also sets out the detailed practical procedures to be followed to achieve the "highest possible quality verification using the best methods and techniques that are currently available and can be used in the prevailing circumstances." In addition, the SIP evaluates the effectiveness of the verification.* Through 1975 a total of 17 model SIPs were prepared, approved and distributed and the Agency's target is to complete SIPs for every facility under its safeguards during 1976.

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* The following discussion draws heavily upon the report of the U.S. Comptroller General on the role of the IAEA in safeguarding nuclear materials, op. cit., pp. 16-18.

As seen by the IAEA, the most important end-product of the production of a SIP is analysis of the limitations placed on the effectiveness of verification activities. An outline for a typical SIP appears in Appendix VIII.

An integral part of IAEA safeguards activities is analysis of diversion possibilities, means of concealment, and measures to assure detection. In making a detection of diversion possibilities, the IAEA inspectorate examines design information, operator practices and procedures, material location and flow, to determine at which point material could be removed with minimum risk of detection. The approach of the IAEA is indicated in the following excerpt of a recent report on experience in the application of the Agency's inspection practices:**

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* Information from S. Nakicenovic, Director, Division of Operations, IAEA. According to Nakicenovic, who originated the idea of SIPs in 1971, their purpose is to: (1) provide the approved basis for the work of the IAEA inspectorate; (2) facilitate standardization of inspection practices; (3) reduce verification activities to the essential minimum; (4) simplify the training of new inspectors; and (5) together with inspection reports, provide IAEA management with a clear picture of the situation at each facility.

** S. Nakicenovic. Experience in the application of inspection practices. Report IAEA-SM201/105, October 1975, p. 6.

> In general, the undeclared withdrawal of significant quantities of nuclear material would also involve falsification of records to conceal the removal by keeping non-explainable fractions of material unaccounted for at such a level as would not warrant further investigation. Containment and surveillance measures such as cameras and seals properly applied are efficient tools for detecting direct, open removal and obviously contribute to preventing it. If a state does not accept effective application of one or both of these two measures, intensified accounting verification is the only alternative.
>
> In the event of surreptitious removal of material with careful adjustment of accounts to conceal the fact, the situation requires a very sophisticated safeguards approach. The judicious combination of the use of accountancy, surveillance and containment measures, with accountancy playing the largest role, can be expected to cope with this diversion method.

The starting point for an inspection is the inventory data submitted by the safeguarded state. Changes in the inventory since the last inspection, based on receipt and transfer notices are recorded. This book inventory then becomes the basis for inspection. To verify the inventory, IAEA inspectors may count, weigh, measure the material; take samples for independent analysis, perform non-destructive tests, inspect seals, and make comparisons with the accounting records.

The end product of IAEA inspection is a detailed report. An idea of the scope and depth of these reports can be had from reference to the model report outline in Appendix IX. The inspection results are reviewed with the facility by the inspector beforehand. Next, the inspector's report is reviewed within the Agency and upon completion of the review, the IAEA provides the inspected state with a statement of results and conclusions. These inspection results are reported only to the state and are not available to other IAEA member states or to the public.

Indicators of IAEA safeguards activities

On June 30, 1975, the IAEA had in force 43 safeguards agreements with non-nuclear-weapons states that had ratified the NPT. Of these, 22 were with states that had significant nuclear activities. Furthermore, safeguards were also being applied under 10 project agreements, 20 safeguards transfer agreements and 8 unilateral submission agreements. All of the latter 38 agreements provide for the application of safeguards under the IAEA's non-NPT safeguards system. During the Agency's fiscal year 1975, it made 502 inspections in 37 states, compared with 434 in 40 states during the preceding year. Of the FY 1975 inspections, 190 were for NPT agreements, in comparison with 147 the year before. Of the 502 inspections, 178 were made of powerplants, 97 of bulk fuel fabrication plants and 227 of other facilities including research reactors.

A list of nuclear installations under Agency safeguards or containing material safeguarded under arrangements approved by the Board of Governors appears in Appendix X. Table X summarizes types of installations under IAEA safeguards. Table XI shows the quantities of nuclear materials under Agency safeguards from 1969 to 1974. Table XII provides other statistical data on IAEA safeguards as of December 30, 1975.

Table X. Nuclear Installations under IAEA Safeguards--1974 and 1975

Facilities	NPT		Non-NPT	
	30 June 1974	30 June 1975	30 June 1974	30 June 1975
Nuclear power stations	12	17	24	30
Other reactors	45	55	65	60
Conversion plants, fabrication plants and fuel reprocessing plants	7	9	19	20
Other separate accountability areas	28	86	88	109

Source: International Atomic Energy Agency. Annual report: 1 July 1974--30 June 1975. Report no. GC(XIX)/544, p. 40.

Table XI. Nuclear Materials under IAEA Safeguards: 1969-1974

	1969	1970	1971	1972	1973	1974
Plutonium (kg)	824	770	1,726	2,900	4,730	6,300
Enriched uranium						
--Total element (tons)	--	243	522	1,178	1,865	2,305
--Fissile content (tons)	4.6	6.1	11.2	26.0	43.0	53.0
Source material (tons)	1,070	1,146	1,200	2,145	3,370	3,910

Source: International Atomic Energy Agency. Annual report: 1 July 1974--30 June 1975. Report no. GC(XIX)/544, p. 40.

Table XII.

Statistical Information on IAEA Safeguards Organization and Activities--1975

1. Number of Professionals

	In Post Dec. 1975	Under Recruitment	To be Recruited	Manning Table 1975
Director	1	-	-	1
Section Chiefs	5	-	-	5
Inspectors	37	12	-	64
Accounts & Reports	3	-	-	4
TOTALS	46	12	-	74

2. Days in field - 1975

	Total		Average per Inspector	
	Days	Trips	Days	Trips
Inspectors only	2,152	171	55	4

3. Instruments in Use End 1975

Cameras	77
NDA Instruments	21
Field Calculators	24

4. Usage of Cameras

Hours of camera operation 1975 450,000

5. Seals

	1974	1975
Number issued in year	2,000	2,000

Table XII. (Continued)

6. Cost of Operations ($)

Cost of Operations ($)	1974	1975
Cost of inspection travel	225,000	315,000
Cost of staff	1,204,000	1,524,000
Cost of equipment purchases	20,000	80,000

7. Number of Facilities under Safeguards - 1975 (excluding U.S. and U.K.)

	NPT	non-NPT
Nuclear Powerplants	20	27
Reactors other than powerplants	8	61
Other facilities or locations	104	102
TOTALS	132	190

8. Safeguarded Nuclear Material at End 1974

	Total Element (kg)	Fissionable Isotopes (kg)	Number of Locations/ MBAs
Special fissionable material			
--Plutonium	6,000		104
--Enriched Uranium	2,177,000	49,700	200
Source material			
--Natural Uranium	3,555,000		112
--Depleted Uranium	282,000		78
--Thorium	11,000		44

The percentage breakdown between quantities under Agency safeguards in connection with NPT, and quantities under other Agency safeguards was as follows:

	Under NPT	Under Other IAEA Safeguards
--Plutonium	25%	75%
--Enriched Uranium	8%	92%
(fissile content)	(10%)	(90%)
--Natural Uranium	83%	17%
--Depleted Uranium	56%	44%
--Thorium	86%	14%

Table XII. (Continued)

9. Agreements in Force at End 1975

NPT-type	45
Non-NPT-type	40

10. Samples

Number received 1974	250
Number received 1975	500

11. (a) Safeguarded Nuclear Capacity at End 1975 -- NNW States

(i) States having NPT safeguards agreements with the Agency	4.4 GW(e)
(ii) States having non-NPT safeguards agreements with the Agency	13.7 GW(e)

(b) Predicted Safeguarded Nuclear Capacity assuming Japan and EURATOM have NPT safeguards agreements with the Agency -- NNW states

(i) States having NPT safeguards agreements with the Agency	19.5 GW(e)
(ii) States having non-NPT safeguards agreements with the Agency	6.3 GW(e)

Source: S. Nakicenovic, Director of Operations, IAEA, January 1976.

VII. CONTRASTING VIEWS ON THE IAEA AND ITS SAFEGUARDS

Safeguards for nuclear materials have been of concern to Congress and the executive branch ever since passage of the Atomic Energy Act of 1946. Safeguards by the International Atomic Energy Agency have been of similar interest and have attracted considerable commentary. To provide further insight into IAEA safeguards in action, there follows a summary of the highlights of four reports: one by the Comptroller General of the United States, one by an advisory committee to the Department of State, one by a key professional member of the IAEA staff, and one by a former IAEA inspector general. The observations, conclusions, and recommendations of these reports suggest past difficulties, present trends and opportunities to further strengthen the IAEA safeguards system as a way to limiting proliferation of nuclear weapons.

The U.S. Comptroller General's report on IAEA safeguards

In July 1974, the Chairman of the House Committee on International Relations asked the Comptroller General to report on international agreements for peaceful cooperation in nuclear energy. Out of this request came the Comptroller General's report on the role of the IAEA in safeguarding nuclear materials, which was released for the hearings of the Senate Committee on Government Operations. The text of the report appears in Appendix I.

The Comptroller General's report is pessimistic about the effectiveness of the IAEA safeguards and raises questions about factors which may limit their effectiveness. It identifies three major policy issues relating to the role of the Agency for consideration by Congress and suggests the IAEA report annually on the amount or percentage of the material which could not be accounted for during Agency inspections. The three policy matters identified by the Comptroller General included:*

> --The need for expanding Agency responsibilities in the physical protection of nuclear material, control of nuclear waste, and safe transport of nuclear materials internationally.
>
> --The technical and political limitations in applying Agency safeguards.
>
> --The lack of sufficiently strong penalties or sanctions on a country that diverts nuclear material for military purposes or that knowingly supplies material to another country for developing nuclear explosive devices.

The report's findings and conclusions raised questions about the limitations of inspection systems, increasing problems in administration of safeguards, the real effectiveness of IAEA safeguards, and potential violation of NPT obligations. The report raised, but did not answer, the question whether U.S. interests are best served through bilateral applications of safeguards by the United States or through Agency safeguards.

The principal findings and conclusions in the Comptroller General's report included the following subjects:**

Safeguards obligations of IAEA members.--Membership in the IAEA does not obligate a country to accept safeguards on its facilities. The report emphasized that India, Argentina, Egypt, Israel, Spain, Japan,

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* U.S. Comptroller General, _op. cit._, p. iv.

** _Ibid._, pp. i-iv.

IAEA responses to diversion.--In case of a diversion of safeguarded nuclear materials, the Agency has three limited options. It can:

--notify member countries and the United Nations,

--suspend Agency membership rights and privileges of the offending state, and

--recall Agency-sponsored material and technical assistance.

Of the latter, the report remarks it is not clear how Agency-sponsored material would be retrieved. In view of the dangers involved in proliferation, the Comptroller General concluded that stronger penalties may be needed for those nations which might violate their pledge to use nuclear materials only for peaceful purposes.

Effectiveness of IAEA safeguards.--The pessimism of the Comptroller General's conclusions is evident in the following observations:

> The real effectiveness of Agency safeguards is not known. There is no public evidence to show whether Agency safeguards have prevented or detected diversion of nuclear material from intended peaceful purposes.
>
> The mere fact that the Agency has never disclosed a diversion is not sufficient assurance for many countries that safeguards are effective.

In support of these conclusions, the report commented further as follows:

> --Effective international safeguards depend in large measure on the intent and cooperation of the country to which they are applied and the adequacy of technological control and implementation.
>
> --U.S. and Agency officials generally conceded that a country could circumvent safeguards if it was willing to assume the risk of detection, incur the expense, and take the trouble to do so.
>
> --Since the Agency does not disclose to member nations results of its inspections, on the grounds that propriety information might be disclosed, the Agency faces the difficult problem of how to assure member nations that safeguards are being applied effectively, fairly, and consistently in all countries.

Bilateral vs. IAEA safeguards.--The report poses, but does not answer, the question of whether U.S. interests are best served through bilateral or Agency safeguards. It observes that Agency safeguards tend to be more uniform and less costly than numerous U.S. bilateral safeguards would be. However, U.S. bilateral safeguards provide the supplier nation (the United States) with greater confidence that material it supplies is not diverted, but provide no similar assurances for materials supplied by other nations.

The Astin report on the IAEA

In April 1971 the Secretary of State established a Panel to recommend how U.S. policy objectives could be achieved through the activities of the IAEA. The Panel was chaired by Allen V. Astin, Director Emeritus of the National Bureau of Standards.* It reported in 1972.**

The Panel made three major policy recommendations concerning the IAEA:

> 1. Continued U.S. support.--The United States Government should reaffirm by repeated statements and by continuing action its vigorous support of the International Atomic Energy Agency especially because of its critical role in carrying out the provisions of the Treaty on the Non-Proliferation of Nuclear Weapons.

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* Other panel members included Professor Cyril L. Comar, head of the Department of Physical Biology, New York State Veterinary College, Cornell University; Professor Eugene Skolnikoff, chairman, Political Science Department, M.I.T.; Dr. Henry DeWolf Smyth, Princeton University and a former U.S. representative to the International Atomic Energy Agency; Dr. Gerald F. Tape, president, Associated Universities, Inc.; and Dr. George H. Vineyard, then Deputy Director, Brookhaven National Laboratory.

** The International Atomic Energy Agency. An appraisal with recommendations for United States policy. A report to the Secretary of State by the Panel to Review the Activities of the International Atomic Energy Agency. Washington, D.C.: U.S. Department of State, 1972, 11 p.

> 2. Balanced IAEA programs.--The United States Government should urge the IAEA to retain a balance in its programs that will demonstrate to all member states that they benefit from its activities--small nations as well as large, developing nations as well as developed nations.
>
> 3. Sustained U.S. funding.--The significance of a strong IAEA is of such major importance to United States and world objectives that its effectiveness should not be limited by indiscriminate budget restrictions...

The Panel emphasized the need for continued U.S. financial support for IAEA safeguards at a time when U.S. participation in international organizations was being reduced. It said:

> ...to insure achievement of the high priority safeguards program may require the development of alternative budgetary practices within the United States Government to protect the overall Agency programs from across-the-board cuts which may be applied from time to time to all international organizations.

In addition to these policy recommendations, the Panel developed conclusions and recommendations concerning the programs and operations of the IAEA that are relevant to the Agency's role in limiting future proliferation. These observations were summarized by the Panel under seven headings:

> 1. Research and staff.--A fully effective nuclear, non-proliferation safeguards program will require, in addition to adequate bud get support, a modest but highly competent in-house related research effort and reasonably long-term, career-type appointments for inspectors.
>
> 2. Technical assistance.--Technical assistance activities should be maintained at least at the present relative level...and be guided by a strong planning and analysis staff to evaluate the effectiveness of assistance projects and optimize the selection of new ones.
>
> 3. Health and safety.--The Agency's work in health and safety and related standards development must keep pace with the growing use of atomic energy throughout the world.

4. IAEA as advisor and arbiter.--As more nations become involved in sharing the benefits of atomic energy, the IAEA has a unique opportunity to serve simultaneously as an expert advisor and a neutral arbiter on such matters as powerplant selection, powerplant location, radioactivity monitoring, safety surveys and nuclear waste management.

5. Needs of developing nations.--The Agency's research program must continue to try to meet the needs of developing nations. In the applied research and development areas, the possibility of small nuclear powerplants for small nations affords a special opportunity.

6. New technological advancement.--It is important for the IAEA to maintain an alert readiness capability for serving potential new developments and applications such as thermonuclear power and the use of peaceful nuclear explosions.

7. Cooperation.--Increased cooperation by IAEA with other international organizations is necessary in order to improve the dissemination of the potential benefits of atomic energy on a worldwide basis.

Concerning safeguards, the Panel found the IAEA program to be an "indispensable reason for the Agency's existence." However, safeguards cannot succeed without effective complementary programs which develop and disseminate the potential benefits of atomic energy (i.e., strong promotional programs.) Furthermore, a weak or marginal safeguards program, in the Panel's opinion, would probably be worse than no safeguards at all because it would tend to further a false sense of security.

Concerning the little-developed health and safety functions of the IAEA, the Panel believed that as more nuclear power is used throughout the world, more nations will find it necessary to call upon the Agency as an independent, objective body for broad-base safety evaluations. So the health and safety responsibilities of the Agency should be expanded to "...embrace broad environmental matters, such as powerplant site selection, waste management and radioactivity surveys."

The Panel also anticipated a substantial role for the Agency to serve as an expert, objective, international advisor and arbiter on matters involving the use of nuclear energy and trade in nuclear materials. As seen by the Panel, it is important that the Agency develop the competence to meet this growing need, and take precautions to insure that the need for objectivity prevails over the Agency's interest in promoting the peaceful use of atomic energy.

The Sanders report on safeguards against nuclear proliferation

During the autumn of 1974, Mr. Benjamin Sanders, a high ranking professional staff member of the IAEA, reviewed the operation of IAEA safeguards, both those applied under the Non-Proliferation Treaty and those applied through other agreements. The resulting report was issued by the Stockholm International Peace Research Institute as background for the NPT review conference of May 1975.*

A principal thesis of the Sanders report is that IAEA safeguards applied through bilateral or multilateral agreements are as much measures to prevent or deter the proliferation of nuclear weapons as are IAEA safeguards applied pursuant to the Non-Proliferation Treaty.**

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* Stockholm International Peace Research Institute. Safeguards against nuclear proliferation. A SIPRI monograph by Benjamin Sanders. Cambridge: The MIT Press, 1975, 114 p.

** Ibid., p. 2.

The Sanders report identified six basic issues for IAEA safeguards, arrived at six conclusions and identified practical problems.

Basic issues of IAEA safeguards.--Six basic issues about IAEA safeguards identified by Sanders concerned differences in purposes of the two IAEA safeguards systems, the definition of peaceful use of nuclear energy, standardization of safeguards agreements, safeguarding of materials produced from safeguarded facilities or materials, safeguards for exports, and termination of safeguards agreements. Because of the unusual vantage point of Sanders' analysis, these six issues are summarized below.

(1) Differing objectives.--The first issue identified by Sanders was the differences between the two IAEA safeguard systems. The first IAEA safeguards system, which is described in the Agency's information circular no. 66, revision 2, is intended to permit the Agency to comply with its statutory obligation of ensuring that assistance provided by it or at its request, or under its supervision or control is not used to further any military purpose. The second IAEA safeguards system, which is set down in the Agency's information circular no. 153, has the objective of timely detection of diversion of significant quantities of nuclear material in NPT non-weapons nations from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices, and deterrence of such diversion by the risk of early detection.

The non-NPT safeguards system does not have specific technical objectives nor does it specify what conclusions are to be drawn from the verification activities of IAEA inspectors or what statements the Agency should make to the safeguarded nation. It focuses upon individual facilities rather than the whole of the nuclear materials and facilities of the safeguarded state. The NPT safeguards system is more flexible. It provides that the technical conclusions of the Agency's verification shall be a statement for each materials balance area safeguarded which reports the amount of material unaccounted for over a specific period. The NPT system applies to all nuclear materials and facilities in the safeguarded nations, so the IAEA inspectors can focus their attention on the most critical facilities.

Another difference important for Sanders is that NPT safeguards agreements contain easier ways to invoke sanctions and other measures in anticipation of an obvious breach of an aggreement. The IAEA agreements with NPT nations provide that the Board of Governors may decide, upon report of the Director General, that an action by the state is essential and urgent to enable the Agency to verify that there has been no diversion. In such a case, the Board can call on the state to take required action. This condition of the NPT safeguards agreements could be involved, for instance, if the state should obstruct the application of safeguards, withhold required information or refuse access for inspection. In addition, the NPT agreements allow the Board to invoke sanctions if it finds the Agency is unable to verify that there has been no diversion. The NPT agreements place the burden of proof on the safeguarded state. In comparison, the agreement with non-NPT states places the burden of proof on the Agency to show there has been non-compliance.*

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* _Ibid._, pp. 8-10.

Sanders sees it important that the NPT safeguards systems assure a thorough exchange of information between the Agency and the safeguarded state whereas the system for bilateral safeguards lacks any provision regarding the kinds of statements to be made after inspection.

These differences for him pose a basic issue for the future of IAEA safeguards.

(2) Definition of peaceful uses.--The statute of the IAEA refers to military purposes and to peaceful purposes, but defines neither. This question of what are the military purposes against which safeguards are applied, and what are the peaceful purposes for which safeguarded materials may be used came to a head after May 18, 1974, when India detonated a nuclear device. The Indian Government declared that its underground test was a peaceful nuclear experiment and that it had no intention of developing nuclear weapons. There is now, for Sanders, a clear trend to interpret safeguards as including measures against the use of special nuclear material for any nuclear explosive device, whatever its intended use.

The fact that the international statute includes no definitions indicates not so much oversight by its negotiators as inability to arrive at common agreement.

(3) Standardization of safeguards agreements.--All IAEA safeguards are applied under terms of agreements between the Agency and the nation involved. Those agreements concluded with NPT nations are largely uniform. However, IAEA safeguards agreements for bilateral or multilateral arrangements "show perceptible variation." Standardization of agreements would

have some benefits. However, Sanders warns, it may not always be a virtue and, if indiscriminately applied, it may actually become counterproductive.*

(4) Safeguards for produced materials.--A complicated issue of potential importance for the future of IAEA safeguards is how far safeguards should follow any special nuclear material produced in or by the use of safeguarded nuclear materials, facilities, equipment, or such non-nuclear items as heavy water. This question implies the principle that the supply of any nuclear item should never further any military prupose and that nuclear material produced from or with the help of nuclear exports also should come under safeguards. This concept is a prime element in the non-proliferation approach of the IAEA's safeguards system that preceded the NPT. This principle of "derivation" or "contamination" if closely adhered to would lead to a proliferation of safeguards from which eventually an international web could be spun through which little, if any, unsafeguarded material would be able to escape.**

A related issue is what happens to safeguards following the termination of an agreement with the IAEA.

(5) Safeguards for nuclear exports.--Article III of the NPT commits the ratifying states not to provide nuclear materials or equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-weapons state for peaceful

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* Ibid., p. 14.

** Ibid., pp. 15-16.

purposes, unless the source or special nuclear material is to be subject to safeguards. Sanders points to differences of opinion as to what items of equipment and material are "especially designed or prepared for the processing, use or production of special fissionable material." More important, a question unanswered by any existing safeguards document is: Does the supply of know-how trigger safeguards?* The NPT is silent on transfer of technology, as are the Agency's NPT safeguards agreements.

Sanders also notes the difficulties of the IAEA in negotiating safeguards agreements with one state in respect of nuclear material and equipment supplied by a different state. As a result, the IAEA has to comply somewhat with the wishes of the supplier states by concluding agreements that reach standards set by these suppliers. Of this he says:

> This is obviously the corollary of the policy of suppliers to demand safeguards against the misuse of the items they provide, while divesting themselves of at least part of the responsibility for doing so by charging the Agency with the application of safeguards.**

From his viewpoint, it would be a great help to the IAEA Secretariat if the Board of Governors were to decide, as it did in the case of NPT safeguards agreements--on a standard text for safeguards agreements. Indeed, if the nuclear supplier states would uniformly require recipient states to submit all their peaceful nuclear activities to safeguards, then a completely standardized approach would be essential.

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* Ibid., p. 18.

** Ibid., p. 21.

(6) Termination of safeguards agreements.--Provisions for termination of safeguards agreements closely relate to nuclear exports. In principle, safeguards should be applied for as long as the supplied item which "triggered" them and the special fissionable material produced from it remain in use. The IAEA Board of Governors has established the desirability of having agreements last for as long as the exported equipment or material is in use. But if the agreement is terminated earlier, safeguards should continue and "pursue" the produced material. This principle will become more important as breeder reactors come into use. At issue for IAEA safeguards is the fact that provisions for safeguards after termination vary between agreements for NPT and Non-NPT states.

The status of IAEA safeguards.--Sanders' analysis leads him to six conclusions about IAEA safeguards which are relevant to consideration of the role of the Agency in limiting proliferation. His conclusions follow:

(1) Safeguards have successfully outgrown the experimental stage. Of this he said:*

> If safeguards help to delay and prevent proliferation of nuclear weapons, or at least contribute to the confidence that a given state is not using its peaceful nuclear activities for military purposes, they will have justified their existence. They also constitute a unique exercise in international verification, which may eventually set a useful precedent for "real" disarmament measures, if not applicable in their entirety then in part...

(2) Safeguards have kept pace with the nuclear industry. Under conditions of present growth, the techniques and manpower resources available

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* Ibid., pp. 55.

are adequate for the time being. Three factors may make it easier for safeguards to keep up with the increased use of nuclear materials:

(i) As more countries acquire complete nuclear fuel cycles, the emphasis on strategically important stages in the cycle will mean a relative simplification of the safeguards effort.

(ii) As more governments establish sophisticated systems of accounting for and control of nuclear material, the safeguarding organization will be able to make better use of the information provided; and

(iii) As experience grows and development leads to better results, improved techniques and more effective instruments can be applied.

Sanders discounts the argument of the Astin Panel that no safeguards would be better than inadequate safeguards. He concludes:*

> ...One may reason that no safeguards would be preferable to inadequate safeguards because the latter might create a false impression of security. This is true. But a control that yields a confidence level of somewhat less than 100 percent is better than no control, as long as one remains aware of the shortcomings of the system.

(3) The burden of safeguards on nuclear industry is tolerable.--In practice, this burden is much less heavy than originally feared. Costs of safeguards in any event are a minor price to pay, given the inherent dangers of the processes and materials used.

(4) The IAEA faces practical problems in the long term.--Competent staff must be recruited. Member states must somehow be assured of the lasting vigilance and incorruptibility of the IAEA staff. The Agency must

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* Ibid., p. 56.

discover how to subsist at the highest possible level of technical competence and to do so in a political environment.

(5) Splitting the IAEA is undesirable.--Various observers have advocated splitting the safeguards functions from the remainder of IAEA activities, so that the promotional and, particularly, technical assistance, activities would not suffer from an emphasis on the regulatory work of safeguards. In his opinion, such an organizational split-off would be a dangerous move that would benefit neither the Agency as a whole nor safeguards.

(6) Cooperation of safeguarded states is essential.--The Agency's experience with safeguards shows that their effectiveness depends on the cooperation of the State concerned and each of the authorities involved: from the civil servant negotiating the agreement to the facility operator who has to make his inventory accessible to IAEA inspectors. This cooperation will be needed wherever and as long as safeguards are applied. The IAEA has to earn this cooperation constantly, by employing a professional, competent approach, tact, discretion and--perhaps most importantly--by never asking for more information than it demonstrably needs. Safeguards cannot be imposed. They can only be made possible by continuing mutual agreement at every level.

The McKnight report on atomic safeguards

The late 1960s were a time of changing public perception of the undesirable as well as the desirable effects of technology. Technological developments were increasingly scrutinized for accompanying social costs and there was much regulatory legislation. Within this context, the United

Nations Institute for Training and Research contracted with Allan McKnight for an examination of the verification of treaty obligations, taking the machinery of the IAEA safeguard systems as a case study. McKnight, who was the IAEA Inspector-General from 1964 to 1968, brought to this analysis an insight of the role proposed for IAEA safeguards during the negotiation of the Non-Proliferation Treaty. His report was published in 1971.*

The primary question of concern to McKnight was whether examination of the IAEA safeguards system justifies any conclusion which might have a general application in the verification of treaties. He concluded that it does.** His view is important for, to the extent he is correct, the IAEA and its safeguards system might well find major new functions in reducing pressure on nations to acquire nuclear weapons by assuring them through inspection that commitments to limit nuclear arms are carried out.

As for a universal system of verification of atomic energy activities, more than twenty years of experience revealed several needs:

(1) political consensus,

(2) scientific consensus on the principles of control,

(3) scientific consensus on the quasi-detail of control,

(4) international cooperation in vigorous research and development to provide effective and credible methods and techniques of control, and

(5) resources adequate to prepare for this potential task.

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* Allan McKnight. Atomic safeguards: A study in international verification. New York: United Nations Institute for Training and Research, 1971, 301 p.

** Ibid., p. 159.

The need for scientific and political consensus.--The first major conclusion from this study of the IAEA's safeguards system was that both political and scientific consensuses were necessary. Their relative importance varied from time to time, occasionally one being a prerequesite to progress on the other. More importantly, the search for scientific consensus was always conducted in the forum of intergovernmental meetings, and official attempts to pursue the search in other ways have not been tried.

From McKnight's observation, although in 1946 there was broad political consensus on the need to control atomic energy, more than twenty years were to pass before political consensus could be reached on the vexing question of reconciling the prohibition of the production and use of atomic weapons with the institution of control to prevent their manufacture. So the pursuit of political consensus at the very least requires extraordinary patience. McKnight did not comment on whether such time would be available in the future. For IAEA safeguards, the experience further shows that, although superpower consensus is a necessary condition for a general political consensus, it is not of itself sufficient. Unfortunately, the course of political development of the IAEA safeguards system did not suggest to him any new or improved methods of pursuing political consensus.

On scientific consensus, McKnight noted that during the international conference on the IAEA statute it was not possible to separate the scientific from the political consensus. So the safeguards article in the IAEA statute represents a mixed consensus. In subsequent discussions of safeguards there has been no clear separation of political and scientific considerations.

But two trends have been evident: First, the proportion of the discussions devoted to technical considerations had constantly increased and by 1968 was predominant; and second, the number of technical representatives participating in meetings likewise increased. In the case of the IAEA safeguards system, the quantity and quality of technical discussion was in direct proportion to the degree of political consensus.

The observed interlinking of political and scientific discussions raised for McKnight the question of whether this methodology could have been improved by conducting the technical discussions separately. On the one hand, close and constant merging of the political and scientific viewpoints was necessary. On the other hand, separate technical discussions might have avoided the time lag which had occurred. His proposed solution was to establish international, independent research institutions to aid in treaty verification. Research institutes could, in the formative stages of any political proposal for the creation of treaty obligations with accompanying verification, seek a scientific consensus as to the mode of verification which meets these criteria. Such institutes would need to possess considerable independence, including financial resources, and could fill the real need for scientists to meet away from tight government control.

The need for research and development.--Examination of the case of the IAEA showed a lag in research and development for control methods from the year 1956, which "marked the first and inchoate political and scientific consensus," to 1967, the first year of real and substantial interest. This eleven-year lag pointed up the need to keep impetus in the processes of both political and scientific consensus so that slowdowns are eliminated and the scientific consensus can keep abreast of the political.

The value of safeguards agreements.--The NPT commits non-nuclear weapons states to conclude agreements with the IAEA for the application of safeguards. This use of agreements has been a real advantage. It relegated to agreement documents the plethora of details regarding the application of safeguards which otherwise would have had to be settled by reopening the IAEA's statutes. Such a renegotiation would have posed a mammoth task for diplomatic negotiations.

McKnight favored the use of negotiated agreements for safeguards as an approach that will merit serious study when the verification of the treaties is considered in the future. He saw IAEA safeguards as furnishing a valuable precedent for all future systems of treaty verification.

National intelligence.--In the Baruch plan of 1946, the proposed international agency would have authority to conduct reconnaissances by air and other means to ensure against clandestine nuclear activities. Other observers have thought too that intelligence should be an active function of any international organization charged with verifying arms control functions. McKnight hesitated to believe that at the present stage of international relations, states would willingly confer on an international organization the powers to collect, evaluate, and act upon intelligence. However, at some point in the future evolution of an international legislative and executive system, the exercise of the intelligence function logically will become necessary. But this point is decades in the future.

Until then, McKnight believes, it is important to note that experience with the safeguards system indicated that verification of a treaty obligation does not displace, replace or incorporate whatever intelligence function is practiced by member states. The IAEA inspection system can only verify activities in a state of which it knows. For the IAEA to practice an intelligence role would require amendment to its international statute. If this were done, what must be avoided at all costs is the possibility that the activities of IAEA as a verification agency would be prompted by reports of national intelligence _clandestinely_ passed to it.*

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* _Ibid._, p. 166.

VIII. TECHNOLOGY AND SAFEGUARDS

The contrasting views of the International Atomic Energy Agency in the preceding chapter suggest some matters for further attention if IAEA safeguards are to be sufficient for the 1980s and beyond. Some of the needed improvements will be organizational. Others will come from new or expanded commitments from IAEA's member states. Beyond these are improvements from development and application of improved technology for safeguards. It is in this last field that the United States can accomplish the most by unilateral action. Here the opportunity lies in a vigorous, national program of safeguards research and development by the Energy Research and Development Administration, the Nuclear Regulatory Commission and the Arms Control and Disarmament Agency carried on in close coordination with the IAEA and nuclear supplier nations.

This chapter briefly outlines the relation between technology and safeguards, indicates some current problems of IAEA safeguards resolvable in part by improved or new safeguards technologies, identifies several highlights of the IAEA s recent safeguards symposium, and discusses the incipient problem of technology as a substitute for human inspection.

Technology and safeguards

In discussing technology and safeguards, the starting point is the realization that social technologies are an important part of the technologies used in safeguards systems. Systems analysis coupled with statistical and probability analysis are integral parts. This use of social technologies has increased since the NPT came into force as a way for NPT states to avoid continuous on-site inspection by the IAEA and to limit the costs and impacts of such inspection upon their commercial nuclear activities.

Safeguards systems universally have three components: containment, surveillance and accountancy. To these U.S. usage adds physical security. IAEA safeguards rely heavily on accountancy because its direct contact with safeguards facilities is generally limited by the safeguards agreements.

The IAEA's Inspector General recognizes the need for improvements in safeguards technologies. Implementation of safeguards requires translation of its conceptual objective into practical terms: actual values have to be defined for "significant quantity", "threshold amount", "detection probability", "confidence level", and "timeliness." *

Accounting for nuclear materials.--The operator of any nuclear facility has to set up a nuclear material accounting system for his own purposes. He keeps records and sends reports to the IAEA in keeping with the safeguards agreement.

For verification of a facility operator's material accountancy, the Agency must use statistical techniques. The numerous components of a materials balance are cross-checked by independent measurement and chemical analysis or non-destructive analysis on the basis of a random sampling plan. At the same time, the accounts are audited for internal consistency and compared with the reality. In principle, during this process, diversion based on accounting falsification should be detected.

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* Cf. R. Rometsch, E. Lopez-Menchero, M. Ryzhov, C.G. Hough, Y. Tapnakow. Safeguards--1975-1985. International Symposium on Safeguarding Nuclear Materials, Vienna, Austria, October 1975, (IAEA-SM-201/103).

Using systems and statistical analysis, the Agency believes that random sampling plans for verification and a corresponding statistical analysis permit it to assess the accuracy of an operator's accounts with a known degree of uncertainty. At this stage, probabilities are introduced. The IAEA has established values for the degree of probability of detecting a significant quantity of material and the probability that this quantity has been correctly established (the confidence level). The first, quantitiative technical objective of safeguards verification is to determine with the given probabilities, and based on the limitations of measurement, that significant quantity which if missing from a facility can be detected.

The significant quantity can then be compared with the threshold amounts of nuclear material needed to make nuclear explosive. IAEA upper limits of threshold amounts are 8 kilograms of plutonium per year and 25 kilograms of contained uranium per year.

The verification of a facility operator's material accountancy by the Agency's inspectorate is a safeguards measure of fundamental importance. The numerous components of a material balance, the receipts into a material balance area, the shipments out of it, the beginning and ending inventories are cross-checked by independent measurement using random sampling plans. The Agency's sampling plans are based on three criteria: *

(1) the probability of detecting a loss of material is chosen to be 0.95 when in fact the true loss is a defined significant quantity;

(2) the probability of falsely concluding that a defined significant quantity is lost when no loss actually occurred is chosen to be 0.05;

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* Rometsch _et al_, SM-201/103, op. cit.

(3) the significant quantities which are based on the measurement uncertainty that can be reasonably achieved with today's measurement technology.

Therefore, the state of the art for nuclear material measurement provides the first basis for defining a significant quantity of nuclear material to be detected if missing. The IAEA had compiled performance data from facility operators and laboratories in member States. From these data, it derived the accuracies shown in Table XIII to apply to various types of facilities. According to the IAEA, some facilities can achieve accuracies better than those of Table XIII. However roundings to the "highest defendable value" are made to avoid discussions over individual performances.* As seen by the IAEA, the best available accuracy figures for closing material balances show the need for additional safeguards actions, for there may be important uncertainties. There will be facilities in which the significant quantities for an annual material balance is larger than the threshold amount. In other facilities, the significant quantity in an annual balance would be only a small fraction of the threshold amount. Facilities of the latter kind can be adequately protected, in the view of the IAEA, by graded safeguards. Table XIV sets out three IAEA proposed categories of nuclear materials that could be protected by graded safeguards. Category 1 would require the strongest system. For those facilities where the significant quantity for an annual overall materials balance exceeds the threshold amount for a weapon, additional safeguards measures are necessary. Physical inventories and balances can be taken more frequently, the

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* Ibid.

Table XIII

Accuracy (Standard Deviation) of a Material Balance Expressed as Percent of Throughput or Inventory

Type of Material	Operator's Accuracy*
Uranium isotope enrichment	± 0.1%
Uranium fuel fabrication	± 0.25%
Plutonium fuel fabrication	± 0.25%
Reprocessing, uranium line	± 0.25%
Reprocessing, plutonium line	± 0.5%
Scrap Recovery	± 0.3%

* These accuracies are expressed as one standard deviation and represent the total random and systematic error components of a material balance; its components stem from all types of measurements involved, such as weighing, metering, spectrometer readings, etc., as well as from sampling, equipment calibration, summing up over several batches and the like.

Source: R. Rometsch et al. Accountancy, Control and Protection of Nuclear Material. IAEA International Symposium on the Safeguarding of Nuclear Materials. Vienna, 20-24 October 1975. (IAEA-SM-201/104). p. 4.

Table XIV

Categorization of Nuclear Material

Material	Form	Category
Plutonium Uranium-233 Uranium enriched to 20% U-235 or more	Unirradiated and non-capsulated	I
Uranium enriched above natural, but less than 20% U-235	Unirradiated and non-capsulated	II
Any nuclear material	Irradiated and/or incapsulated	III
Natural uranium Depleted uranium Thorium	Any	III

Source: R. Rometsch et al. Accountancy, Control and Protection of Nuclear Material. IAEA International Symposium on the Safeguarding of Nuclear Materials. Vienna, 20-24 October 1975. (IAEA-SM-201/104). p. 3.

facility can be broken down into many smaller materials balance areas, and the technologies for sampling, analysis and interpretation can be improved.

Inevitably there may be some difference between physical inventories and accounting records because of uncertainties in sampling and analysis and possible loss or diversion. The difference between these two amounts is defined as material unaccounted for, or MUF. Evaluation of the quantity of material unaccounted for and the uncertainty with which this quantity is known, leads the IAEA to a final conclusion whether or not diversion has occurred.

The effectiveness of the IAEA's accounting, sampling, measurement and analysis all depend upon the state of instrumentation and methodology, while the judgement whether or not a diversion has occurred must rest heavily upon applied probability theory and practice. So improvements in these technologies can affect the future reliability of IAEA and national safeguards.

Some practical problems for IAEA safeguards development

Recently the IAEA's Inspector General outlined three practical problems for IAEA safeguards that implicitly outline requirements for improved social and physical technologies.* These problems result from the anticipated establishment of more material balance areas, increased flow of bulk nuclear material, and an increase in material balance areas in which missing significant quantities of material would be more than the threshold amount to make a nuclear explosive. Of these matters, he said:

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* R. Rometsch. IAEA international safeguards. 16th annual meeting of the Institute of Nuclear Materials Management, June 18, 1975.

> Firstly, there will be many more material balance areas or facilities in which the nuclear material accountancy cannot be done by item identification and counting. Consequently, the easily achieved high accuracy of material balance closing by this method will no longer be characteristic for almost all nuclear materials subject to IAEA safeguards.
>
> Second, the through-put of nuclear material in bulk facilities will increase considerably. The accuracies of material balance closing represents an almost constant percentage of the throughput; hence in absolute terms the uncertainties become larger.
>
> ... [Third] there will be material areas in which the yearly statistically significant quantity to be detected, if missing, will become greater than the threshold amount needed to manufacture a nuclear explosive device. It will be necessary to increase the frequency of materials balance closing, of subdividing material baance areas into smaller units, and of taking complementary measures of physical containment and surveillance--the latter preferably by means of automatic instrumentation.

The International symposium on safeguarding nuclear material

In October 1975 the IAEA sponsored an international symposium on the safeguarding of nuclear materials in Vienna.*

Reports from the United States were predominant. These originated in the Energy Research and Development Administration, the Nuclear Regulatory Commission, and their contractors. Among the many U.S. papers, three were closely related to overall to problems of safeguards.

C. A. Bennett of the Batelle Memorial Institute, an ERDA contractor, discussed reasons why social values are important in planning a safeguards effort.* He noted that the priority which a nation gives to its safeguards effort will reflect the level of the perceived threat, the perception of the resulting consequences, as well as the nature of competing demands of national resources. Furthermore, a nation's ultimate selection of the safeguards mechanisms which will achieve a required or desired level of protection will be influenced by the legal and cultural norms of the nation. Bennett's approach involves estimating factors such as the likelihood that the safeguards system will interrupt any action sequence and the consequences associated with the events and the frequency with which adversary actions will be attempted. One strength of a safeguards program lies in the fact that the adversary must carry out an entire sequence of events successfully, while the safeguards system need only detect or stop the sequence at one point prior to successful completion.

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* For a good survey report of the symposium, cf. "International symposium on the safeguarding of nuclear material." Nuclear engineering international, v. 20, December 1975, pp. 1021-1024.

Orval E. Jones of ERDA's Sandia Laboratory, which develops nuclear weapons, described how societal risk analysis is used for developing an advanced physical protection system in the United States.** One tool used is a computer simulation model to assess the cost effectiveness of alternative physical protection systems under various levels of threat.

G. Robert Keepin of ERDA's Los Alamos Scientific Laboratory, reported on work to provide a practical capability for accurate and rapid

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* C. A. Bennett. System design and evaluation for national safeguards systems. IAEA International Symposium on the Safeguarding of Nuclear Materials. Vienna, October 1975. (IAEA-SM201/38).

** Orval E. Jones. Advanced physical protection systems for nuclear materials. IAEA International Symposium on the Safeguarding of Nuclear Materials. Vienna, October 1975. (IAEA-SM-201/35).

inventory taking at essentially any time on very short notice.* Such capability would be needed by plant operators in assessing the extent of an accident or in evaluating the validity of blackmail threats based on claims of possession of materials from a specific plant. A system of in-plant dynamic material control is being developed at the Los Alamos Plutonium Facility. This "DYMAC" system incorporates an automatic measurement system relying heavily on non-destructive analytical instruments to provide real time, quantitative assay data at key measurement points; direct, automatic transfer of data into a central computer; and an automated accounting system to give quick material balance statements on small segments of a plant. The implicit sub-division of nuclear materials flows into many small segments is seen as an essential way to keep the significant quantities reliably measurable in a safeguards system well below threshold quantities.

Systems analysis vs. human inspection

The statute of the IAEA gives it the right to send inspectors into member states. The inspectors are to have access at all times to all places and data and to any person who by reason of his occupation deals with materials, equipment, or facilities which are required to be safeguarded. This emphasis upon inspection was blunted in subsequent negotiation of the NPT. Here the systems-analysis approach favored by West Germany, prevailed. The Germans emphasized the social technologies of statistical analysis, material balance areas and strategic points measurement, as an alternative to unlimited human inspection. This approach has limited the scope and access of inspectors in NPT states, yet, according to one analyst, it lacks unimpeachable demonstration of the technical feasibility of complete containment of nuclear materials between measuring points. This potential deficiency presumably was conceded by NPT negotiators to get prompt and widest possible implementation of the treaty.* In essence, the NPT safeguarding system of the Agency illustrates a new facet of the relationship between technology and international politics, namely the use of social technologies to avoid politically objectionable components of widespread human inspection.**

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* G. Robert Keepin and William J. Maraman. Non-destructive assay technology and in-plant dynamic materials control--"DYMAC." IAEA International Symposium on the Safeguarding of Nuclear Materials. Vienna, October 1975. (IAEA-SM-201/32).

Commentary

Improved technologies for safeguards clearly will be important to the future reliability and effectiveness of safeguards systems, both those of the IAEA and individual nations. Despite anticipated improvements, there will never be a wholly accurate system for accounting for nuclear materials, nor will sampling, analytical and statistical systems ever offer obsolute certainty. Some degree of uncertainty will always be present. At issue for further development of safeguard technology is how much uncertainty is acceptable now, how much will be acceptable ten years from now, and what can be done in the meantime to assure the needed improvements.

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* Robert Pendley and Lawrence Scheinman. "International safeguarding as institutionalized collective behavior." International organization, v. 29, 1975, pp. 612-613.

** Ibid., p. 616.

There is also the risk of over reliance upon technology to solve political problems. The instance of technology replacing inspectors is probably the best indicator of this risk. Once again, a continuing balance of costs and benefits will be needed. Fewer inspectors cost less to keep in the field, but unthinking instruments cannot observe clews of clandestine diversion.

Considering the comparatively massive U.S. research and development for nuclear safeguards, there is reasons for Congressional attention to the organization and management of the U.S. program, its coordination among Federal agencies and its coordination with the IAEA and other major nuclear supplies states. How to get promising safeguards developments out of the laboratories and into timely, practical application is another matter warranting attention. As noted at the start of this chapter, development of better safeguards technologies for the 1980s and beyond is an area where unilateral United States action can be directly effective.

IX. MULTINATIONAL FUEL CENTERS

One potentially major new role for the International Atomic Energy Agency in limiting proliferation concerns multinational fuel centers. The idea of regional centers owned by multinational organizations to enrich uranium or to reprocess spent nuclear fuel has attracted considerable attention. It could offer powerful inducements to non-weapons states to forego nuclear energy independence and to rely instead upon regional organizations for vital nuclear services. By providing an alternative to national facilities, these centers presumably could reduce the spread of the industrial ability to make nuclear weapons materials. The United States supports this concept and the IAEA has taken initial steps to assess the prospects for such centers. If the concept proves viable, the IAEA would certainly have the role of applying its international safeguards system to such centers. Beyond that are possible expanded IAEA roles including full operation of all safeguards systems, operating facilities for multinational organizations, or even arranging for organization and financing of regional nuclear fuel centers.

This chapter outlines briefly the United States' position on the multinational fuel centers, and recent pertinent advice to the Committee on Government Operations.

Secretary Kissinger's proposal

On September 22, 1975, Secretary of State Kissinger in his speech to the United Nations called for the establishment of multinational regional nuclear fuel cycle centers which would reduce the incentive for small and inefficient reprocessing facilities, limit the possibility of diverting peaceful nuclear materials to national military use, and create a better framework for applying effective international safeguards. Since then little additional detail about the Secretary's thinking on these centers has been published.

An ERDA view

Soon after, on October 30, 1975, an official of the Energy Research and Development Administration identified some of the "difficult and complex questions" to be answered before the multinational fuel center concept can be realized:*

> There are, of course, difficult and complex questions to be answered before this concept can be realized. For example, who would make the decisions on the location of a regional facility? Who would construct and operate it--private industry, an intergovernmental body, an international organization? Who would put up the funds for the large capital investment required?

The IAEA study

The IAEA has begun a study of regional nuclear fuel cycle centers, with United States support and participation. Preliminary results of the study, which should be completed sometime in 1977, suggest that large-scale centers could obtain significant economies of scale compared with smaller national reprocessing plants. But more important from the non-proliferation viewpoint, these centers may be an attractive alternative to national reprocessing plants, particularly for countries with limited nuclear capacity.*

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* Nelson F. Sievering, Jr., Prepared statements in U.S. Congress. House. Committee on International Relations, Subcommittee on International Security and Scientific Affairs, Hearings. Nuclear proliferation: future U.S. foreign policy implications. 94th Cong., 1st sess., 1975, p. 152.

As for the IAEA's interest, during October 1974 its staff made a preliminary study of economic benefits from regional centers for nuclear fuel reprocessing and waste management. This study indicated that sufficient advantages could be identified for regional pooling of reprocessing loads to justify a detailed study that would include, in addition to technical and economic considerations, other aspects such as legal, institutional, environmental, safety and fuel cycle self-sufficiency. The IAEA's Scientific Advisory Committee endorsed the expanded study.**

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* Fred C. Ikle, Director, U.S. Arms Control and Disarmament Agency. Statement before the Senate Committee on Foreign Relations, Subcommittee on Arms Control, International Organizations and Security Agreements. February 23, 1976.

** In doing so, it emphasized the following points:

1. The Study should encompass a fuel cycle center in a broad form including fuel fabrication facilities as well as reprocessing and waste management.
2. Recognition should be given to the fundamental fact that a major fraction of the environmental, safety and safeguards problems of nuclear power arise because spent fuel is reprocessed.
3. The study should consider all options for handling spent fuel from the time it is discharged from the reactors. This should include storage of the spent fuel for an indefinite period.
4. The transportation aspects of the various options should be given special consideration since this is a strong emotional factor in the mind of the public.
5. If at all possible, centers should be located at sites which offer a good probability of being acceptable for permanent geologic disposal as well as retrievable storage of wastes.

CF., IAEA. Regional nuclear fuel cycle centers: IAEA study project. September 1975, p. 4.

The stated objectives of the IAEA project now in progress are threefold:*

1. To develop the methodology for assessment of alternative strategies for establishment of integrated regional nuclear fuel cycle centers, so as to evaluate their advantages and disadvantages vis-a-vis dispersed fuel cycle facilities.

2. To prepare a report on this methodology, including illustrative examples of approaches and disadvantages to member states, for the use of those organizations interested in the implementation of nuclear fuel cycle activities.

3. To provide a mechanism for establishment of a forum where member states and other interested entities can work out alternative strategies pertinent to nuclear fuel cycle activities.

Dr. Gerald Tape, U.S. representative to the IAEA, cautions that the Agency itself does not have the kind of in-house staff competence necessary to do a complete study, so it will have to call on many nations with the expertise to contribute both financially and in the provision of experts.**

Advice from witnesses

The Committee on Government Operations heard differing views on multinational fuel cycle centers. Dr. Theodore Taylor sees the concept as superficially good, but doubts that existence of such centers would deter a nation that wants weapons materials from building a clandestine facility. In his opinion, until very detailed studies of alternative possible sites, participating countries, and related spent and fresh fuel transport routes have been made, it will not be possible to answer questions about the possible increase in vulnerability of fuel to theft or sabotage during transport. He wonders what countries would be willing to deal with the problems of temporary and long-term disposal of radioactive wastes from such a facility.

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* IAEA. Regional fuel cycle centers: IAEA study project, September 1975, p. 5.

** Cf., U.S. Congress. House. Committee on International Relations, Subcommittee on International Security and Scientific Affairs. Hearings. Nuclear proliferation: future U.S. foreign policy implications. 94th Cong., 2d sess., 1975, p. 133.

Mr. Dwight Porter and Professor Mason Willrich* are more optimistic. Porter sees the concept as making economic sense and providing an added reassurance to the world that plutonium from reprocessing plants will be used only for peaceful purposes. He sees no opposition on the part of potential nuclear trading partners such as Iran, the Philippines, and other NPT states. There are, however, many political and economic problems which user nations cannot solve alone. In his view, there must be a major international effort to study the problem in depth, find a solution, or come up with alternatives. Noting the IAEA effort, Porter anticipates that the United States may well have to use its own national resources to further these objectives. Congress itself may have to consider the possibility of funding such international ventures. Porter notes that the IAEA statute empowers the Agency to run, even to own, large business-type installations and speculates whether this unique authority, not yet utilized, might provide an approach to the establishment of multinational regional centers.

Professor Willrich favors multilateral interdependence in nuclear power. This condition will exist when a number of countries jointly own and operate a nuclear fuel cycle facility. As examples, he noted the Eurochemic reprocessing facility of the Organization for Economic Cooperation and Development and the Eurodif enrichment plant. Eurochemic, even though currently shut down, is an example of a truly multinational venture. On the other hand, Eurodif, which is moving toward construction, is a French-led venture to build an enrichment plant with other countries--perhaps including Iran--being essentially passive investors. Participation in multilateral ventures may or may not be regionally oriented. In any event, Willrich sees the participants as feeling secure in their supplies or services from facilities that they partly own, even though the facilities are not on their territory. The decision of where to locate a multinationally owned facility, of course, would be a question of high political importance.

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* Mason Willrich, Professor of Law, University of Virginia.

Dr. Albert Carnesale focused in detail upon multinational nuclear facility concept.* He defined the function of a multinational facility (MNF) to be the accomplishment of one or more segments of the nuclear fuel cycle, such as the enrichment of uranium, storage of spent fuel, reprocessing of spent fuel and long-term storage of radioactive waste. In most cases an MNF could offer economies of scale unachievable with national facilities. Participants could include private firms, government-owned enterprises, national governments, international organizations or some combination of these. An MNF, while usually proposed in a regional context, need not be so restricted. Indeed, it may well prove easier to achieve cooperation among distant nations than closely neighboring ones. Of course, some common sense will be useful in considering possible combinations:

> The hypothetical case of an MNF for spent fuel storage, participated in and operated jointly by the U.S. and Canada, and

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* Dr. Albert Carnesale, Program for Science and International Affairs, Harvard University.

located on a remote island in the Atlantic Ocean, is a better candidate for consideration than is the (at least) equally hypothetical case of an MNF for reprocessing, owned by the U.S., the U.S.S.R., Argentina, and India, located in Pakistan, and operated by the Organization of African Unity.

Apparent advantages of an MNF.--Carnesale sees four apparent advantages of an MNF:

(1) A higher threshold in member countries for a decision to make nuclear materials.

(2) More effective safeguards against diversion of nuclear materials and at lower cost.

(3) U.S. participation in MNFs would be in full accord with the spirit of the NPT.

(4) World experience in operation of transnational institutions.

Apparent disadvantages of an MNF.--Carnesale identified four offsetting apparent disadvantages of MNFs:

(1) Transfer of sensitive dual-purpose technologies to nations which might not otherwise have obtained them.

(2) Risk of appropriation of a center by the host nation.

(3) Little if any direct impact on the proliferation problem because of lack of interest in states intent on producing nuclear weapons.

(4) Premature stimulation of plutonium recycling.

Some questions for consideration.--Carnesale's analysis identified five questions to be addressed in assessing an MNF:

(1) Would the MNF serve as a substitute for national facilities in some or all of the participating countries?

(2) Would the MNF whet appetites for national facilities in non-participating countries: If so, would the supplier nations agree not to cater to these appetites?

(3) Would the MNF retard (or at least not accelerate) the spread of technologies for the production of nuclear weapons?

(4) Would the MNF be adequately safeguarded against diversion and protected against theft and sabotage? If so, would the political climate of the host country be sufficiently stable?

(5) Would the MNF support (or at least not undermine) other approaches to nonproliferation?

A conclusion and three policy suggestions.--Carnesale concluded that the MNF concept is no substitute for other approaches to curbing the spread of nuclear weapons, but it might provide a useful adjunct. So, although the United States should proceed with caution, it should proceed. His consideration of the non-proliferation implications of the MNF concept led to these three suggestions for U.S. policy:

> 1. The U.S. should neither promote nor participate in MNFs for reprocessing unless and until the economic advantages and general acceptability of plutonium recycling have been established firmly.
>
> 2. The U.S. should explore the possibility of participating in an MNF for the enrichment of light-water reactor (i.e. low-enriched) fuel with particular attention to the task of minimizing the transfer of enrichment technology.
>
> 3. The U.S. should promote vigorously the establishment of an MNF for spent fuel storage. An installation of this kind could be of immediate economic benefit, and would enable us and others to experiment with the MNF concept without the proliferation or risks associated with enrichment and reprocessing facilities.

The NRC's Nuclear Energy Center Cite Survey

Of some relevance to multinational fuel cycle centers is the recent report of the Nuclear Regulatory Commission's nuclear energy center site survey.* The NRC reports that the survey supports the conclusion that it can be feasible and practical to locate nuclear fuel-cycle facilities on nuclear energy center sites, and that, although the need for such centers is not compelling, they might offer public benefits.**

Concerning safeguards advantages, the NRC report is ambivalent. It recognizes that collocation of spent-fuel reprocessing and mixed-oxide fuel fabrication facilities might be advantages for safeguards by reducing routine shipment of plutonium. Nevertheless, the NRC's ongoing Special Safeguard Study indicates that effective safeguards can continue to be achieved without eliminating the shipment of plutonium materials. Other benefits that NRC thinks could derive from fuel cycle nuclear energy centers include:**

(1) Economies in construction costs, although these aspects have not been studied in detail.

(2) Reduction in the number of sites that might have to be dedicated to permanent care of residual radioactive materials from fuel reprocessing.

(3) Significant opportunities for improved waste management systems and economies of scale in constructing waste treatment and management facilities.

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* Section 207 of the Energy Reorganization Act of 1974 required the NRC to carry out a survey of possible sites for nuclear energy centers and to evaluate the results of the survey.

** U.S. Nuclear Regulatory Commission. Nuclear energy center site survey--1975. Executive summary. January 1976. Report NUREG-000-ES, p. 3.

These advantages would appear to apply also for multinational regional fuel cycle centers.

Commentary

On the whole, there is an attractive plausibility to the idea of multinational, regional fuel cycle centers. However, there are substantial obstacles that should not be underestimated. Above all, the successful establishment of such centers will demand a quantum jump advancement in international relations and administration. Many innovations in organization, planning, financing, staffing, and management of international organizations will be necessary. It is in this respect that the IAEA could be of the greatest assistance. The IAEA could play several roles. It could take over the entire safeguarding of the centers, including physical security. It could provide a cadre of professional persons and otherwise assist in the initial organization and staffing of a multinational organization. It could directly operate such centers, much as contractors operate major ERDA facilities, or as the United Kingdom Atomic Energy Authority has operated an experimental reactor for several European countries.

In any event, any study, analysis and planning for multinational, regional fuel cycle centers should look beyond the initial organization and financing to the matter of long-term performance responsiveness. The experience in the United States with autonomous regional seaport, airport, water supply and sewerage authorities suggests a cautious approach. Some of these ventures that originally promised a ready solution to vexing regional problems have since given rise to unresponsive bureaucracies beyond the influence and oversight of the participating goverments.

X. THE IAEA AND PROLIFERATION OF NUCLEAR WEAPONS

The role of the International Atomic Energy Agency in limiting proliferation of nuclear weapons will be a continuing matter of interest, assuming that present forecasts for world use of nuclear power are valid. In an age of sometimes vexatious and controversial technological developments, the urgent need now perceived to limit proliferation poses new problems for international organizations and for the United States Government. Both executive and legislativ e branches, are concerned with nuclear power and proliferation. Whole new chapters must be written in the theory and practice of international relations and law, and on international organizations and their administration, as the world learns to live in an anticipated age of nuclear power.

Whether the nations of the world can agree to a quantum jump in the non-proliferation functions of the IAEA is a question of uncertain answer. More certain is that living in a future world of breeder reactors, plutonium recycle, and easy enrichment of uranium will be more risky and unstable if the IAEA does not continue to evolve.

This chapter briefly speculates upon the future role of the IAEA in limiting proliferation. While its focus is upon the IAEA, other international organizations--worldwide and regional--also have possible roles in limiting proliferation. What these other organizations do or do not do will inevitably affect the future role of the IAEA. The factors affecting these interactions are not examined in this report. They appear to be a likely subject for further congressional attention.

Table XIV lists six major approaches to limiting the proliferation of nuclear weapons and indicates possible roles for the IAEA and other international organizations including multinational nuclear centers. For these approaches, the IAEA now has one major role, one limited role, three potentially significant future roles, and one minor role.

Dissuading nations from proliferation

Concerning dissuasion of non-weapons states from acquiring nuclear weapons, the present limited IAEA role is to reduce pressures for proliferation through verification of NPT and other commitments not to use safeguarded materials or facilities for weapons or other military uses. It seems unlikely this role will be expanded. Creating world conditions that will relieve pressures for proliferation, or discourage proliferation, is clearly in the domain of international foreign and military policy. In the future, the IAEA can help to carry out such policies as they may limit proliferation, but it is unlikely to be a major generator of such policies.

Limiting the spread of the proliferation base

Concerning the spread of the ability to make nuclear weapons, here the IAEA could play additional roles in limitation of proliferation. In particular, the Agency might be empowered to act as a world broker to apply some control over international exports of sensitive nuclear products and technologies, or to promote and perhaps operate multinational nuclear centers.

The world broker role could mark a revival of the atomic materials pool of President Eisenhower's Atoms-for-Peace proposals. The IAEA role could include all international nuclear fuel transactions, including

Table XV

ROLES OF INTERNATIONAL ORGANIZATIONS IN LIMITING PROLIFERATION OF NUCLEAR WEAPONS

Approach	IAEA	UNITED NATIONS	EURATOM	MNFC*
Dissuasion	limited	major	uncertain	uncertain
Limiting the spread of proliferation base	potential	minor	substantial	substantial
Detection of diversion or theft	major	none	major	none
Verification of treaty compliance	potential	none	uncertain	none
Physical protection of nuclear materials and facilities	potential	uncertain	major	major
Response to diversion or theft of nuclear materials	minor	major	minor	none

* Multinational fuel centers.

arrangements for enrichment and reprocessing, so that no supplier state would deal directly with a customer state. The purpose of such a role would be to make supplies of nuclear fuels and fuel services more attractive and reliable by insulating their supply from the tensions that arise among nations, and thus encourage nuclear interdependence rather than nuclear independence. The Agency's broker role would be strengthened were it to have a substantial pool of nuclear fuel materials to sustain its supply function during times when international tensions might cause one or more supplier states to withdraw from the world market. A brokerage role of the Agency could also help finance safeguards through fees.

An increased role in decisions affecting exports by supplier nations of critical nuclear items and technology could also increase world assurance that commercial interests of supplier nations would not negate their responsibility in limiting further spread of the proliferation base. The IAEA currently is limited to informal efforts to persuade the supplier nations to adopt common policies concerning exports of enrichment or fuel reprocessing technology. It is also a public repository of parallel statements by nuclear supplier states of their export policies. Since the IAEA already has authority to review proposed nuclear facilities under its safeguards, it would seem but an incremental step to extend that review to proposed exports of sensitive nuclear items or technology. IAEA participation could be as little as submission of a proliferation advisory report to an exporting state, or as much as authority to prohibit all such exports except those it licensed. By analogy, these functions could resemble that proposed for the Arms Control and Disarmament Agency in S. 1439 or the export licensing authority of the Nuclear Regulatory Commission. The idea of direct IAEA involvement in export control, while appealing, may be deceptively simple in that it implies assignment of radical new authority to an international organization, the exercise of which sometimes would be at cross purposes with the desires of major nuclear exporters. Whether the United States could persuade the member states of the IAEA to grant such authority and to abide by decisions adverse to their domestic interests is a troublesome issue that must be faced. Also, there is the question whether the United States itself would accept such IAEA controls.

Promotion of multinational nuclear centers

A promotional role for the IAEA for multinational nuclear centers offers some prospects of gaining more support for such ventures than if proposed solely by the nuclear supplier nations in concert. Also, the Agency could help in the organization, staffing, management and other aspects of international administration, and provide the resources of an established, reputable agency experienced in nuclear technology. Conceivably, the Agency could be the operator of such centers for regional organizations, or perhaps even the owner and operator of such facilities throughout the world. For the Agency to succeed in such ventures, however, would require the coordinated and full cooperation of major industrial nations to supply the financing and the requisite plant and equipment as well as education and training for IAEA operative personnel. Such a role could also reduce the influence of individual nuclear supplier nations on the world market which might be viewed as contrary to their export interests.

Detection of diversion and theft

The IAEA's responsibilities for nuclear safeguards under the NPT and its statute provide the Agency with its primary role in non-proliferation. There seems little prospect for major changes in this role unless all of the weapons countries of the world put their civil nuclear activities under IAEA safeguards. Whether the increased assurances against diversion from such an expansion would be worth the cost and effort is an open question. Some observers would hold that such an expansion would produce little benefit unless accompanied by nuclear disarmament. Also, the prospects of getting the Soviet Union and China to agree appear dim indeed.

Verification of treaty compliance

One function of the IAEA under the NPT is to verify by inspection the commitments of the ratifying states. The agency now has well over a decade of practical working experience with an international inspectorate. On the whole, inspection has not imposed the burdens once feared by some observers. IAEA safeguards also provide a test-bed for inspection for verification of other treaties. One of the major long-term benefits of the Agency may be demonstration that international inspection for other treaty commitments is tolerable and practicable.

Since reduction of pressures for proliferation through effective arms control and disarmament is a major way to limit further proliferation, the IAEA's role could be expanded in several ways. The Agency obviously can continue to demonstrate the feasibility of international inspection and to identify those factors or features which may need special attention in establishing other international inspection programs. Perhaps it could supply the cadre of experienced staff for new international inspectorates. Perhaps it might even perform such inspections. The idea of such an IAEA role is clearly speculative. Consideration of it, however, can help to better understand what can reasonably be expected of the IAEA as an element in the future control of proliferation.

Physical security

Ever since publication of the Rosenbaum Report on physical security by the Congress in 1974, there has been sustained interest in the issue of physical security for nuclear materials and facilities.* The issue was debated extensively during the enactment of the Energy Reorganization Act of 1974 which abolished the Atomic Energy Commission and reassigned its functions between the new Energy Research and Development Administration and the new Nuclear Regulatory Commission. It is also an element in the consideration of present Federal organization for control of nuclear exports and the responsibility of the NRC to look into safeguards of importing countries. This interest logically leads to the question of the IAEA s future role in physical security.

The possible roles of the Agency in physical security range from its present informal advisory role to more formal responsibilities assigned by amendment of the international statute. The IAEA could be authorized to set minimum standards for physical protection of nuclear materials in safeguarded countries and to inspect for compliance with the standards. A more novel role would be to supply physical security services for nuclear materials in international transit, or for multinational fuel centers, or perhaps even upon request for sensitive facilities in individual countries. Also, there is a possible role of the Agency in gathering and assessing intelligence on world terrorist activities as these might relate to nuclear power and informing governments concerned of its estimates.

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* On April 30, 1974, Senator Ribicoff placed in the Congressional Record the text of the special safeguards study made for the Atomic Energy Commission by a panel chaired by David M. Rosenbaum. The report identified many shortcoming of AEC safeguards, particularly the physical security measures to deal with terrorist attack or sabotage.

Once again, consideration of such roles is a speculative venture of uncertain outcome. Again, however, such consideration could help to better understand which future non proliferation roles for the IAEA are feasible and which are unattainable.

Response to diversion or theft

Some criticisms of IAEA safeguards hold them to be insufficient because the Agency itself cannot automatically impose powerful sanctions upon nations that violate their safegaurds commitments. The most the IAEA can do now is to inform the world through the United Nations and IAEA member states, call for return of nuclear materials supplied under safeguards agreements, and suspend the offending nation from privileges of IAEA membership. Once the nations of the world are informed of a diversion of safeguarded materials, it is up to them by international action--political or otherwise--to deal with the situation. If the world community lacks the interest, will or ability to respond to a significant diversion, it is futile to propose the IAEA do the job for them. So it seems unlikely that the IAEA could ever have more than a minor role in organizing a world response to diversion. Its job is to sound the alarm. The world community of nations has to extinguish the fire.

EXCERPT'S FROM THE
COMPTROLLER GENERAL'S
REPORT TO THE COMMITTEE
ON INTERNATIONAL RELATIONS
HOUSE OF REPRESENTATIVES

ROLE OF THE INTERNATIONAL
ATOMIC ENERGY AGENCY IN SAFEGUARDING NUCLEAR MATERIAL
Department of State
Energy Research and Development Administration

DIGEST

WHY THE REVIEW WAS MADE

GAO was asked to provide reports on a broad range of subjects concerning international agreements for peaceful cooperation in the field of nuclear energy. This is GAO's third such report and deals with the role of the International Atomic Energy Agency in safeguarding nuclear material.

FINDINGS AND CONCLUSIONS

The Agency, an autonomous organization under the aegis of the United Nations, administers an international nuclear safeguards program designed to detect diversion of nuclear materials for nonpeaceful purposes.

Its 106 member countries include all nations with significant amounts of nuclear activity, except the Peoples Republic of China and the Republic of China (Taiwan). The latter's nuclear facilities, however, are subject to Agency safeguards. (See pp. 1 and 11.)

Membership in the Agency does not obligate a country to accept safeguards on its facilities. For example, nuclear facilities of major nuclear weapons countries, such as the United States and the Soviet Union, are not subject to Agency safeguards except on a voluntary basis. In addition, India, which exploded a nuclear device in 1974, along with Argentina, Egypt, Israel, Spain, Japan, Pakistan, and South Africa are members with nuclear facilities not subject to Agency safeguards. (See pp. 8, 11, and 13.)

The Agency's safeguards system consists of material accountability, onsite inspections, and surveillance and containment devices such as cameras and seals. The principle is that the detection capability of the system will deter a would-be diverter. However, limitations in the scope and applicability of inspections must be recognized.

--Agency safeguards are designed only to detect diversions on the national level, and it is assumed that member nations will protect nuclear material from terrorist or subnational groups. (See p. 14.)

--Agency safeguards do not include physical protection, the safe international transport of nuclear material, or the safeguarding of nuclear waste. (See p. 28.)

--The Agency does not have the authority to seek out undeclared or clandestine nuclear facilities and cannot pursue or retrieve diverted nuclear material. (See p. 15.)

With the expected spread in peaceful uses of nuclear energy throughout the world, problems encountered in the administration and implementation of the Agency's safeguards system can be expected to increase. They relate to such matters as:

--Adequacy of material accountability records within the member countries and their compatibility with the Agency's system. (See p. 20.)

--Continuing need for more advanced measuring instrumentation. (See p. 21.)

--Equitable apportionment of costs of the safeguards system among member nations. (See p. 22.)

--Differences in safeguards agreements with member countries and their interpretation. (See p. 23.)

Actions the Agency can currently take in the case of nuclear diversion are

--notification to member countries and the United Nations,

--suspension of Agency membership rights and privileges, and

--the recall of Agency-sponsored material and technical assistance.

It is not clear, however, how Agency-sponsored material would be retrieved. (See p. 16.)

In view of dangers involved in the spread of nuclear weapons capability, stronger penalties may be needed for those who might violate their pledge to use nuclear material only for peaceful purposes. (See p. 33.)

Real effectiveness of Agency safeguards is not known. There is no public evidence to show whether Agency safeguards have prevented or detected diversion of nuclear material from intended peaceful purposes. (See p. 16.)

The mere fact that the Agency has never disclosed a diversion is not sufficient assurance for many countries that the safeguards are effective. (See p. 27.)

--Effective international safeguards depend in large measure on the intent and cooperation of the country to which they are applied and the adequacy of technological control and implementation. (See p. 14.)

--U.S. and Agency officials generally conceded that a country could circumvent safeguards if it was willing to assume the risk of detection, incur the expense, and take the trouble to do so. (See p. 20.)

--Since the Agency does not disclose to member nations results of its inspections, on the grounds that proprietary information might be disclosed, the Agency faces the difficult problem of how to assure member nations that safeguards are being applied effectively, fairly, and consistently in all countries. (See p. 27.)

The question of whether U.S. interests are best served through bilateral or Agency safeguards is difficult to answer. Agency safeguards tend to be more uniform and less costly than numerous bilateral safeguards would be. Bilateral safeguards provide the supplier with greater confidence that material it supplied is not diverted but provide no assurances on material supplied by others. (See p. 7.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

As requested by the Committee, GAO did not obtain formal agency comments on this report. However, the report was discussed with officials of the agencies involved, and they generally agreed with the information.

MATTERS FOR CONSIDERATION BY THE COMMITTEE

The Committee, together with the Joint Committee on Atomic Energy, may wish to pursue with executive branch officials major policy matters related to the role of the Agency, including:

--The need for expanding Agency responsibilities in the physicial protection of nuclear material, control of nuclear waste, and safe transport of nuclear materials internationally.

--The technical and political limitations in applying Agency safeguards.

--The lack of sufficiently strong penalties or sanctions on a country that diverts nuclear material for military purposes or that knowingly supplies material to another country for developing nuclear explosive devices. (See p. 33.)

In addition, the Committees may wish to discuss with executive branch officials the desirability of proposing that the Agency publish annually a report showing, by member country, the amount of nuclear materials subject to its safeguards and the amount and/or percentage of material which could not be accounted for during Agency inspections, while not divulging host country proprietary information. This could help assure all member countries that safeguards are effective and that safeguarded material is not being diverted. (See p. 34.)

CHAPTER 5

CONCLUSIONS AND MATTERS FOR CONSIDERATION BY THE COMMITTEE

The real effectiveness of IAEA safeguards is not known. There is no public evidence to show whether IAEA safeguards have prevented or detected diversion of nuclear material from intended peaceful purposes. The mere fact that IAEA has never disclosed a diversion is not sufficient assurance to many countries that IAEA safeguards are effective.

Effective international safeguards depend in large measure on the intent and cooperation of the country to which they are applied and the adequacy of technological control and implementation. However, technological control in the absence of genuine political commitment is inadequate. IAEA officials have stated that safeguards would never be completely effective--they could never be fully confident that no material has been diverted. U.S. and IAEA officials generally conceded that a country could circumvent safeguards if it was willing to assume the risk of detection, incur the expense, and take the trouble to do so.

Although certain technical conclusions can be derived from the safeguards activities, the extent to which IAEA safeguards are effective is largely a matter of judgment. Since IAEA does not disclose to member nations the results of its inspections, on the grounds that proprietary information might be disclosed, it faces the difficult problem of how to assure member nations that safeguards are being applied effectively, fairly, and consistently in all countries.

Membership in IAEA does not obligate a country to accept safeguards on its facilities. For example, the nuclear facilities of major nuclear weapons countries, such as the United States and the Soviet Union, are not subject to IAEA safeguards except on a voluntary basis. In addition, India, Argentina, Egypt, Israel, Spain, Japan, Pakistan, and South Africa are IAEA members with nuclear facilities not subject to IAEA safeguards.

Limitations in the scope and applicability of IAEA inspections must also be recognized. IAEA safeguards are designed only to detect diversions at the national level. IAEA safeguards do not include physical protection, the safe international transport of nuclear material, or the safeguarding of nuclear waste. It does not have authority to seek out undeclared or clandestine nuclear facilities and cannot pursue or retrieve diverted nuclear material.

With the expected spread of peaceful uses of nuclear energy throughout the world, the problems encountered in the administration and implementation of the IAEA safeguards system can be expected to increase. They relate to such matters as:

--The adequacy of material accountability records within the member countries and their compatibility with the IAEA system.

--The continuing need for more advanced measuring instrumentation for inspectors.

--The differences in safeguards agreements with member countries and their interpretation.

--The equitable apportionment of the costs of the safeguards system among member countries.

If IAEA cannot verify the nondiversion of special nuclear material, the country involved is to be given a "reasonable time" to take corrective action before noncompliance procedures may be initiated. Such procedures include notification to member countries and the United Nations Security Council and General Assembly. Continued failure by the country to rectify the situation may also result in the recall of IAEA-sponsored material and technical assistance as well as suspension of membership rights and privileges. By the time these sanctions are made, the country may have had sufficient time to complete its weapons development. It is also not clear how IAEA-sponsored material would be retrieved.

In view of the dangers involved in the spread of nuclear weapons capability, stronger penalties may be needed for those who might violate their pledge to use nuclear material for peaceful purposes.

MATTERS FOR CONSIDERATION BY THE COMMITTEE

The Committee, together with the Joint Committee on Atomic Energy, may wish to pursue with responsible executive branch officials major policy matters related to the role of IAEA, including:

--The need for expanding the responsibilities of IAEA in the physical protection of nuclear material, the control of irradiated nuclear waste, and the safe transport of nuclear materials internationally.

--The technical and political limitations in applying IAEA safeguards.

--The lack of sufficiently strong penalties or sanctions on a country that diverts nuclear material for military purposes or knowingly supplies material to another country for the purpose of developing nuclear explosive devices.

In addition, the Committees may wish to discuss with executive branch officials the desirability of proposing that IAEA publish annually a report showing, by member country, the amount of nuclear materials subject to its safeguards and the amount and/or percentage of material which could not be accounted for during the inspections, while not divulging host country proprietary information. This could help to assure all member countries that safeguards are effective and that safeguarded material is not being diverted.

APPENDIX 2

SELECTED EXCERPTS FROM

"COMMERCIAL NUCLEAR POWER IN EUROPE: THE INTERACTION OF AMERICAN DIPLOMACY WITH A NEW TECHNOLOGY"

by

Warren H. Donnelly

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PURPOSE

In December 1972 the report, "Commercial Nuclear Power in Europe: The Interaction of American Diplomacy with a New Technology,"[1] set out many conclusions and identified many issues relating to cooperation between the United States, other countries and international agencies in the civil use of nuclear energy. Many of these observations appear relevant to the current congressional interest in limiting further proliferation of nuclear weapons by control of U. S. nuclear exports and strengthening international safeguards.

There follows selected excerpts from this report on these matters.

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[1] U.S. Congress. House. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Commercial Nuclear Power in Europe: The Interaction of American Diplomacy with a New Technology. (by Warren H. Donnelly) Washington, U.S. Govt. Print. Off., 1972. 163 p.

II. SOME FACTS ABOUT NUCLEAR POWER

Some Limitations of Safeguards

Control of nuclear materials, both because of their monetary value and for their utility to make nuclear weapons, would seem to require a combination of accounting and physical controls and protection. This double control is not now in practice. Safeguards systems do not extend to physical protection against theft or diversion, but are designed only to detect such theft or diversion. The hope for safeguards is that their detection capability will deter a would-be diverter by his risk of early detection and unmasking in the world community. This limitation of safeguards has important consequences. It means that assuring the physical security of nuclear materials is a separate responsibility of the possessing nation.

A second limitation of safeguards is technical and statistical. Experience indicates that large users and producers of nuclear materials can never know precisely how much materials they have; there can be no assurance of the detection of every slight diversion. Unavoidable process losses and statistical errors in sampling and measurement set limits on accuracy. These limitations do not mean that safeguards cannot achieve a high level of effectiveness. They do mean that some margin of error is inescapable which might mask some small diversions. The diversion of substantial amounts of plutonium or highly enriched uranium-235 would probably be detected, but there remains the nagging possibility that enough materials might be diverted without detection to make a few nuclear weapons. The possession of a few illicit weapons by a smaller nation, or possibly a non-national organization which might obtain the nuclear materials on a nuclear black market, is a real disadvantage of nuclear power to be weighed when considering the balance of cost and benefit from a policy of promoting its world use. Moreover, the higher the rate at which atomic fuel is used, reprocessed, and increased by breeding, the larger will be the margin of uncertainty attributable to statistical error and the greater the chance of undetected diversion.

V. BILATERAL AGREEMENTS FOR U.S. TECHNICAL ASSISTANCE TO COMMERCIAL NUCLEAR ENERGY IN EUROPE

Conclusion and Current Issues

One of the first assignments resulting from the effects of the discovery of nuclear fission for American diplomacy was to negotiate and administer a web of bilateral agreements for U.S. technical assistance to foreign nations. Though of lesser status than treaties or executive agreements, they nonetheless obtained for the United States unusual rights not available through the more traditional and presumably more potent and durable instruments of international relations.

The bilateral agreements were created to provide special technical assistance to foster civil use of nuclear energy abroad. These research and power agreements demonstrated an effectiveness for supplying information, materials, equipment, services, training, and advisers to nations that were interested in nuclear power. The power agreements also were notable in the rights they obtained for the United States for control and safeguarding of nuclear fuel materials and certain equipment. In the participating nations, inspectors of the United States had access to the places where U.S. nuclear materials were being used to inspect them and to verify their quantities. In addition, because of forethought of U.S. policy and the work of the diplomats and negotiators, the bilateral agreements had provisions which ultimately were to enable the International Atomic Energy Agency to gain useful experience with working safeguards.

The success of the U.S. bilateral agreements, however, worked against one major goal of Atoms for Peace. Because the agreements provided many advantages to the other countries, and because this web of agreements obtained for the United States influence and leverage that it otherwise might not have had, there has been a reluctance to shift the channel for U.S. technical assistance for nuclear power in Europe and elsewhere, from country-to-country agreements to the International Atomic Energy Agency. From a global viewpoint, it might be seen that the United States and other world leaders in nuclear power are in competition with the International Agency when they deal directly with other countries in supplying technical assistance. There is an implied balancing of advantages to goals of individual nations versus the anticipated advantages of a strengthened International Agency.

Assuming that it is in the best interests of the United States and world peace to see the Nonproliferation Treaty operate a full effectiveness, it may now be time for the United States to reexamine the present roles of bilateral agreements and of the International Agency as the means for furnishing future technical assistance and incentives for nuclear power. Channeling more U.S. aid through the IAEA could be expected to strengthen the agency. However, to deemphasize the present network of bilateral agreements with individual nations and with multinational bodies such as Euratom would lose for the United States the benefits associated with direct dealings.

The United States supplying of technical assistance in nuclear energy through direct agreements between the United States and other nations, and groups of nations, has been successful and might well provide a model for measures to accelerate research and development for fusion and other new sources of energy.

VI. CREATING AN INTERNATIONAL ORGANIZATION: THE INTERNATIONAL ATOMIC ENERGY AGENCY

Conclusions and Current Issues

Had the International Atomic Energy Agency evolved in the direction indicated by President Eisenhower's idealistic Atoms for Peace proposal, it could have had a major influence upon development of commercial nuclear energy in Europe as a channel for technical assistance and nuclear materials. However, the tensions of the cold war effectively precluded such a role. While the United States was the most generous contributor to the IAEA, it chose not to promote the Agency as a distributor of nuclear materials or the custodian of a pool of such materials. Nor did the United States support an international regulatory or standard-setting function for the IAEA for design and operation of nuclear power plants. On the other hand, the Agency provided an arena wherein U.S. and Soviet representatives could meet in an atmosphere where political differences were less pronounced than for other cold war circumstances.

From the beginning of the IAEA, the United States and the U.S.S.R. as the two principal "have" nations in the world's nuclear community were pushed together in their participation in the Agency's activities by the pressures of the other largely "have-not" nations. These circumstances engendered some mutual interest and the resulting experience demonstrated the possibilities for cooperation between the two governments in diplomatic, legal, and technical matters relating to nuclear energy. While such cooperation has become common in 1972,[171] it was most unusual during the formative years of the IAEA. The IAEA provided a sheltered field wherein member states belonging to widely differing world power blocs could cautiously experiment with new relations. On the other hand, the variety of viewpoints and national desires represented among the members of the Agency on occasion led to strained relations within the IAEA's governing bodies and has tended to limit the Agency to a lowest common denominator of inoffensive activities.

The IAEA has been a useful test-bed to demonstrate a limited form of international inspection, a demonstration that can be important for U.S. interests if international limitations upon armaments are agreed upon. The IAEA, with strong U.S. backing, has demonstrated on a small scale how international safeguards for nuclear materials can work. Perhaps more important, it has done so without generating any insoluble problem of national sovereignty. Whether the United States and other nations will now be willing to provide the financial and technical support required by the Agency to expand its safeguards functions enough to adequately implement the Nonproliferation Treaty remains to be seen.

Several specific questions relating to the IAEA are likely to confront U.S. diplomats and policymakers in the future. These questions can be expected to bear upon:

(1) Establishing and enforcing international standards and guides for the design, construction, and operation of nuclear power plants, nuclear fuel reprocessing plants, and perpetual radioactive waste storage facilities;

(2) Establishing and enforcing international regulations for the shipment of highly radioactive materials;

(3) Assessment of environmental effects of nuclear facilities located so near to national boundaries that such effects could be expected to extend across national borders;

(4) Supplying nuclear fuel materials;

(5) Providing for the perpetual storage of radioactive wastes from nuclear power;

(6) Safeguarding of nuclear fuel materials for commercial nuclear power;

(7) Possible future relations with the regional nuclear energy agencies of the Soviet bloc nations.

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[171] The United States and the U.S.S.R. signed an agreement on scientific and technological cooperation on May 24, 1972, that goes beyond the usual exchange of ideas and opens the way to scientific joint research undertakings and cooperative projects. It established for the first time a U.S.-Soviet Joint Commission on Scientific and Technical Cooperation. Cf. Claire R. Geier, *The U.S.-Soviet Agreement in Science and Technology* (Washington, D.C.: The Library of Congress, Congressional Research Service, August 10, 1972, report No. 72–179 SP.

VII. CREATING A REGIONAL NUCLEAR ORGANIZATION

Conclusions and Current Issues

Now well into the second decade of its existence, Euratom presents a mixed picture of success and failure. Its various agreements with the United States have allowed Euratom to supply European nuclear power programs with considerable enriched uranium and plutonium under its own safeguards system. The United States cooperated by regrouping its bilateral agreements with Euratom members into a single agreement with Euratom. The Agency has created an effective European research capability for nuclear energy.

On the other hand, these encouraging moves toward European unity have been steadily eroded by a wave of nuclear nationalism. Since 1961, a marked trend toward nationalism in the nuclear industries of the member nations has nearly drowned Euratom, leaving it since 1968 without a 5-year program, with sharply reduced funding and, perhaps worst of all, without an involvement in application of nuclear power technology in Europe. Political difficulties have blocked cooperation with Euratom's supply function for nuclear materials and with plans to develop a European enrichment capability.

Euratom's successes have come in activities which were distantly linked to the competitive status of the national nuclear industries of France, Italy, and West Germany. These included model legislation to encourage uniformity in national regulation of radiological effects of nuclear power, research into subjects without immediate commercial application, and safeguarding nuclear materials. But Euratom has not been able to weld together the separate national nuclear industries of its members. Euratom research and development which approached commercial application has been opposed and was ultimately terminated. The differing ideas of France, Italy, and West Germany as to which kind of nuclear power technology to exploit created tensions that on several occasions all but paralyzed Euratom's research and development programs and led to the charge that some member nations were benefiting disproportionately at the expense of others. The inability to form a common European approach to nuclear technology has proved advantageous to the U.S. nuclear industry and in the 1970's the use of U.S. nuclear power technology is well established in Europe, having overmatched the alternative favored by the French. Among the Euratom members there is increasing use of joint ventures between companies in the several national European nuclear industries as an alternative to working through Euratom. There are signs also that Euratom's laboratories may have outlived their usefulness and now face the problem of what to do with their human and physical resources. Steps to open Euratom's facilities to non-nuclear research and development are one indication of the situation. What can be learned from this trend to convert Euratom's research installations into general research facilities for the European Economic Community can be of interest to the United States for two reasons. First, a successful transition of a substantial part of Euratom's research capabilities to non-nuclear research could strengthen the competitiveness of European high-technology goods and services in the world markets vis-a-vis those of the United States. Second, a successful transition might well provide useful insights into the problems of conversion of existing scientific and technical institutions into new fields as their original field becomes worked out, or as changes in national priorities and programs make them redundant. This transition, of course, is the problem of the U.S. defense and aerospace industries with the continuing unemployment of highly skilled scientists, engineers, and technicians.

Several issues for United States foreign policy and Euratom that may need future attention include:

(1) To what extent should the United States encourage Euratom to build and operate a uranium enrichment plant in Europe?

(2) In supplying U.S. enrichment technology, if this is done, to what extent should the United States attempt to recoup the domestic investment in developing that technology through licensing fees or royalties?

(3) Considering forecasts that the United States will soon have to decide whether to fund expansion of its domestic enrichment plants, what would be the effect upon U.S. foreign policy of a limitation or termination of the longstanding U.S. commitment to supply enriched uranium to Euratom for commercial nuclear power in Europe?

(4) What voice should the United States seek in Euratom's setting of standards governing the environmental effects of nuclear power plants, and standards for review and approval of the siting, design, and construction of nuclear power plants? In exporting nuclear power plants, will the commercial interests of the U.S. nuclear industry be sufficiently protected by a U.S. policy of non-intervention?

(5) Considering the perplexing status of technology for long term storage of the intensely radioactive wastes from nuclear power, in what ways would domestic interests of the United States benefit from measures to stimulate Euratom work in this field?

(6) Considering the priority being given to development and demonstration of the breeder reactor in the United States and the considerable interest among Common Market countries in breeder technology, to what extent should U.S. foreign policy attempt to influence European breeder research in the direction of the technology favored by the United States? Conversely, considering criticisms of the U.S. breeder program for concentrating too much on only one breeder concept, to what extent might U.S. foreign policy attempt to guide European breeder research toward other potentially competing breeder concepts as insurance against an unexpected setback or failure in the U.S. domestic program?

VIII. JOINT UNITED STATES-EURATOM RESEARCH AND DEVELOPMENT

Conclusions and Current Issues

American diplomacy was able to arrange with Euratom for joint programs of demonstration and research and development, but could not assure the impetus needed to reach the desired goals. The negotiators did not produce a truly joint undertaking, but rather two parallel, closely coordinated programs in which each party controls its own funds.

The diplomatic effort did produce several working nuclear power plants in Europe that demonstrated U.S. nuclear technology both for European and domestic U.S. nuclear markets. The joint programs did provide experience in the operation of joint boards, experience that could be useful for future multinational ventures. It may be worth inquiring how much of this experience has been recorded and analyzed for future reference.

The diplomatic effort of organizing the joint programs did benefit the U.S. nuclear industry, which had the opportunity to build several more working power plants than would otherwise have been possible. On the other hand, the program never measured up to the initial expectations and suffered from long delays.

As the United States moves into the mid-1970's in the face of growing national and international imbalances in supply and demand for energy, it may well be useful to inquire what can be learned from the joint programs. There was a working together of government agencies, universities, and industrial organizations in several countries and useful research was performed. Perhaps the experience with the joint programs could point the way toward future ventures to develop new energy sources, such as large-scale use of solar energy, or toward conservation of energy through expedited development of magnetohydrodynamics (MHD). Both the strengths and weaknesses of the Euratom venture could be instructive in planning such new developments on an international basis.

IX. THE NUCLEAR ENERGY AGENCY: ANOTHER REGIONAL APPROACH TO INTERNATIONAL ORGANIZATION FOR NUCLEAR ENERGY

Conclusions and Current Issues

The comparative freedom from crises of the OECD's Nuclear Energy Agency provides a marked contrast to the trials and difficulties of Euratom. What accounts for this difference? It may well be that the fundamental differences between the organiaztions provide an answer. NEA appears as the traditional kind of international undertaking, being more of a confederation of member states than a separate, supernational organization. Perhaps relations with the NEA have been easier in that the Agency is clearly a working tool of the members rather than a form of international government. Perhaps, also, less was expected of the NEA. For example, its charter was not to create a European nuclear industry but rather to help with technical assistance. Whatever the reasons, the history of the NEA has shown more cooperation and less friction among participating members than was the case with Euratom. Future planners of international technological ventures may benefit from an identification and analysis of the factors that have caused this difference.

The relations between the United States and the NEA on one hand and the United States and Euratom on the other are also different. The United States cooperated substantially with Euratom in an ambitious joint research program, but has preferred a more conventional role in its relations to the NEA, limiting its participation largely to exchange of information about projects of mutual interest. That the United Kingdom was a member of NEA but not of Euratom may have been a factor in the difference in U.S. participation. In the formative period of the NEA, the United States was concerned with nuclear competition from the United Kingdom, which had begun a large-scale deployment of nuclear power well before the United States and appeared to be a formidable future competitor in the world nuclear market. U.S. financial support to NEA could have been seen as fostering a competitive British nuclear technology, while U.S. financial support to Euratom enjoyed the advantage of being earmarked for projects explicitly beneficial to U.S. nuclear technology.

With the United Kingdom and other European nations now joining the Common Market, the membership of NEA and Euratom will further overlap. In turn, this raises the question about the separate functions of these organizations, and also their relationship to the International Atomic Energy Agency. Should all three continue as now constituted? Should the NEA be combined into Euratom? Should Euratom be permitted to fade away and its scientific resources be transformed into a general European scientific capability, leaving nuclear technology to the NEA? How would such changes affect U.S. interests? These are some questions that seem likely to occur if nuclear power in Europe is to fulfill the role projected for it.

X. U.S. FUEL FOR EUROPEAN NUCLEAR POWER

Conclusions and Current Issues

During 1970–71, diplomacy and diplomats were involved with, or affected by, a number of initiatives taken by European governments to secure for themselves a role in uranium enrichment. Taken as a whole, these initiatives suggest that the forces of fragmentation within the European nuclear community remained strong. They reflected also U.S. desires to encourage multilateral construction and operation of a large enrichment plant in Europe as an alternative to a proliferation of smaller separate facilities. The initiatives included:

(1) A declaration by the EEC of the need to construct a European enrichment facility;

(2) A tripartite agreement among Britain, West Germany, and Holland to develop the gas centrifuge for enrichment of uranium;

(3) A decision by the French Government to plan construction of an enrichment plant in Europe;

(4) A French decision to study construction of an enrichment facility by means of collaboration of technical companies;

(5) The announced AEC intention to permit a limited number of American companies to have access to secret enrichment technology; and

(6) An AEC offer to help foreign countries, particularly European, to build an enrichment plant.

Although the United States had built its uranium enrichment plants to produce nuclear materials for weapons, these facilities have become an important economic asset for the United States and for its nuclear foreign policy. Because of these facilities, the United States has been able to offer long-term commitments to supply enriched uranium for nuclear power plants in Europe. For the next few years, these plants have sufficient capacity to do so. But within this decade, decisions must be made that will decide the future competitive standing of the United States in the enriched-uranium market. Some related issues include the following:[326]

Will the United States, for reasons of economic and foreign policy, seek to preserve its position as the world's leading supplier of enriched uranium and enrichment services?

What measures should the United States consider if other nations, singly or in concert, attempt to break the long-standing U.S. enrichment monopoly by building their own enrichment facility?

Is the further development of gas centrifuge technology in Europe likely to lead to a technological surprise for the United States, should the economic and technological feasibility of this technology be demonstrated?

What measures can or should the United States consider to discourage further development of the gas centrifuge?

What diplomatic options are open to the United States should the Soviet Union seriously enter the world enriched-uranium market?

Since supplying enrichment services requires the use of large amounts of electricity which, in the United States, comes from coal-burning powerplants, and considering present air pollution problems of the United States and the environmental impacts of mining coal, do the foreign policy benefits of supplying enrichment services to foreign customers balance the energy and environmental costs to America?

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[238] As this case study went to press, two events underscored the possibilities for change in the role of the AEC in furnishing enrichment services for foreign and domestic customers. On December 6, 1972, the AEC gave notice of a temporary suspension of new contracts for enrichment services except for (1) firm quantity type contracts under negotiation on that date, (2) contracts which have been submitted to customers for execution, and (3) new short-term contracts to provide firm quantities of enriching services needed by domestic and foreign customers to cover near-term requirements. The Commission imposed this temporary suspension to permit time to complete its review of alternative methods of contracting and to establish ". . . such modified method as will provide greater assurance that the needed enrichment capacity at the Commission's plants will be available on a timely basis. . . ." Another reason was to provide further assurance of ". . . augmentation of available enriching capacity in the 1980's and beyond by private resources." Cf. *Federal Register*, vol. 37, December 8, 1972, pp. 26145–26146.

The second event was an AEC announcement of December 6, 1972 which stated that it is not the intention of the Commission to construct new enrichment plants to meet growing requirements since it believes that the private sector can undertake to provide the required capacity on a timely basis. The AEC, however, will remain in a position to furnish enrichment services to the private sector to the extent of its available capacity. To stimulate the requisite private effort, the AEC announced proposed modifications to its regulations which would make the government's enrichment technology available. (Cf. *Federal Register*, vol. 37, December 9, 1972, pp. 26345–26348.) At a press conference, AEC Chairman Schlessinger said that if industry does not do the job, the government must do it. He also said that a vigorous industry could maintain the "clear" U.S. advantage in exporting nuclear power technology and by the 1980's might produce $3.5 billion a year in foreign sales compared with $900 million in 1972. (Cf. *Washington Post*, December 9, 1972, p. A–3.)

XI. THE NONPROLIFERATION TREATY AND SAFEGUARDS

Conclusions and Current Issues

The development of international safeguards is an evolving interaction between nuclear technology and American diplomacy. The United States has consistently supported international safeguards administered by the International Atomic Energy Agency. U.S. support of the Nonproliferation Treaty has reaffirmed the importance that this Nation attaches to effective performance of safeguards—a technological activity growing out of the discovery of nuclear fission. As a gesture to persuade other nations that the inspection provisions of the Treaty do not impose an unacceptable interference with national sovereignty, the United States has volunteered to place its civil nuclear industry under IAEA safeguards, and the United States has already voluntarily placed several nuclear facilities under these safeguards.

Another task for U.S. diplomacy will be to assure a satisfactory outcome of the agreement reached between the IAEA and Euratom for continuation of the Euratom safeguards system in cooperation with IAEA safeguards. These safeguards arrangements between two international agencies will be important for the future of Euratom. A success would add reason for future support to this declining organization. Also, success could present an interesting issue for U.S. diplomacy should the Soviet Union propose a similar arrangement for nations within its bloc.

So far the IAEA safeguards system has proven tolerable to nations exposed to it under the "trilateral" nuclear assistance agreements between the United States, individual other nations, and the Agency. Can IAEA experience, derived from safeguarding comparatively small amounts of nuclear materials in special curcumstances, provide an adequate base for the routine safeguarding of large quantities? The amounts of nuclear fuel materials now used for civil nuclear power are modest, as is the amount of plutonium being produced as a byproduct of commercial nuclear power in Europe and the United States. Yet if present estimates for growth of nuclear power are correct, within the decade there will be a marked increase in both the number of nuclear power plants and supporting facilities to be safeguarded and the amounts of material in process, transit, and inventory, factors which would be expected to increase the temptation and opportunities for attempted diversions. U.S. foreign policy toward commercial nuclear energy in Europe can be expected to have some influence on the nature and pace of this future growth, and upon the attitude of the governments involved toward the IAEA and the safeguards system.

Specific issues of importance in U.S. foreign policy for the 1970's and the 1980's appear to include the following:

(1) *A point-of-no-return decision:* At this time, in 1972, nuclear power, while growing rapidly, is still not a major component of electricity supply in either the United States or Europe. If the risks to world peace from potential diversion of nuclear materials cannot adequately be controlled by safeguards, there may still be time to deemphasize nuclear power despite the economic loss of much of the past national investments in bringing nuclear power to its present state. Within a few years, however, the nations of the world will pass a point of no return beyond which a decision to abandon or limit nuclear power will no longer be a manageable policy alternative. At issue for U.S. foreign policy is a final decisive international risk-versus-benefit analysis for nuclear power in terms of dangers to world peace from diversion of materials to use in clandestine weapons.

(2) *U.S. support for IAEA safeguards:* The present demonstration of IAEA safeguards would not have been possible without U.S. support and cooperation. But what of preparing the IAEA to apply its safeguards systems to commercial nuclear power throughout the world? For U.S. diplomacy there are interacting foreign and domestic considerations. On the one hand, strong past U.S. support would suggest that future U.S. support should be expanded so that the Agency can prepare for the anticipated rapid, worldwide growth in the use of nuclear power. On the other hand, domestic demands for funds and changing attitudes toward foreign aid seem likely to make such expansion difficult. In these circumstances, it would seem that U.S. diplomacy has a two-pronged responsibility for the future of this international control of a potentially dangerous technological product. First, it will have to help assure conditions for the IAEA adequately to perform its safeguards function. Second, it will have to help generate the domestic understanding and commitment needed to assure adequate U.S. support.

Another related function for U.S. diplomacy is likely to be that of working to determine the future shape, scale, and balance of the IAEA activities. If only the safeguards function expands, then bit by bit other Agency functions may atrophy so that ultimately the IAEA may become primarily a safeguards agency. This condition may or may not be in the ultimate U.S. interest. IAEA concentration on safeguards should improve the management and effectiveness of this function. However, the Nonproliferation Treaty offered non-weapons states the promise of benefits from nuclear energy. Could this promise be adequately fulfilled by an international agency whose technical assistance and related functions have been stunted by asymetrical preoccupation with safeguards?

U.S. diplomacy inevitably will have a major responsibility for working out answers to these issues.

(3) *Voluntary safeguards in the United States:* Two Presidents have committed the United States voluntarily to place its nuclear industries under IAEA safeguards as an inducement to persuade non-weapons nations to sign and ratify the Nonproliferation Treaty. At the moment, the ratification process is incomplete and the United States has not been called upon to honor this offer. However, it may be timely to consider foreign and domestic policy implications of the offer, such as:

The acceptable scale of IAEA inspections;

The degree of reliability desired;

Whether the function of IAEA safeguards will be independently to detect unauthorized diversions, or to assure that national safeguards systems are adequate to do so and to test them occasionally;

Necessary limitations upon IAEA use of inspectors who are nationals of nations whose foreign and domestic policies are in conflict with those of the country to be inspected; and

Available measures to protect trade secrets of the host country's nuclear industry while at the same time providing adequate access by IAEA inspectors to nuclear materials in process and in inventory.

(4) *The physical security issues:* The IAEA safeguards system is limited in purpose to detecting diversion of nuclear materials. It does not extend to security and other measures to protect the materials against attempted diversions. To what extent, if any, should U.S. foreign policy attempt to extend the IAEA safeguards function into physical protection and security of nuclear materials and to apprehension of would-be diverters?

(5) *Increased U.S. assistance in nuclear energy:* A premise of the Nonproliferation Treaty is that the nuclear weapons states will share with the non-weapons states the benefits of nuclear energy to induce them to agree to international safeguards. This commitment has implications for foreign and domestic U.S. policy for nuclear energy. To what extent is the United States prepared to shape its development of nuclear power technology to meet the needs of the non-weapons states? Are present forms and channels of U.S. nuclear technological assistance sufficient for purposes of the Treaty, or need they be broadened and expanded? Should the U.S. develop those nuclear power technologies which can use natural uranium or thorium as fuel and thus avoid the requirements for enrichment and safeguards? These are some of the questions that combine elements of nuclear technology, domestic energy policy, and diplomacy which will have to be answered during the 1970's.

XII. SOME ISSUES RECAPITULATED

How the discovery of nuclear fission came to influence American diplomacy and foreign policy has been examined in this case study. Clearly these interactions are of interest to students of the relations among science, technology, and American diplomacy. But why should the Congress and the public be interested in the past and future implications of nuclear energy for diplomacy in the face of all the other matters clamoring for attention?

Two primary reasons support such interest. First, after several false alarms in Europe—or perhaps they were preliminary warnings unrecognized—it is now becoming evident that the nations of the world are facing a growing gap between demand for and supply of fuels for energy. The United States and other nations, including those of the European Economic Community and the Soviet bloc, expect that nuclear energy will supply a large part of the electricity required in the future, perhaps as much as half by the 1990's. U.S. diplomacy and foreign policy should prepare now to take this anticipated energy gap into account, especially since this Nation is expected to import greatly increasing amounts of oil and natural gas in the decades ahead. Thus considerations of foreign policy may become an input into formation of domestic policy to develop nuclear power further as a means of reducing the U.S. need to import fuels, thereby easing international tensions and competition for scarce resources. Second, European experience with international safeguards with its feature of international inspection could provide a working demonstration of inspection for future arms control and disarmament. Realization of this benefit alone would, for many observers, be well worth the U.S. effort thus far devoted to fostering nuclear power in Europe.

The United States, by deliberate foreign policy decisions, has chosen to foster commercial nuclear power in Europe. While it is not clear in the literature what quantitative effects U.S. policies and programs have had, they did contribute to the creation of one global and two regional international organizations for nuclear power, and to the establishment of commercial nuclear industries in technological nations of Europe, primarily France, Italy, and West Germany. Yet U.S. support has not led to a unified European nuclear industry, which is splintered among competing national industries. So the grand hope of the European Economic Community for a truly European nuclear energy industry remains unrealized. This shortfall from the goals of *A Target for Euratom* has benefited the U.S. nuclear industry, which by itself is today appreciably larger and stronger than any one of the European nuclear industries.

Commercial nuclear power in Europe is beginning to lessen European dependence upon imported fuels. Assuming that European progress with the demonstration and deployment of the breeder reactor will further reduce this dependence upon uncertain sources of fuels, such as those of the Middle East or the Soviet Union, Europe should be less vulnerable to energy blackmail.

Granted the historical validity of the reasons for U.S. foreign policy toward commercial nuclear power in Europe, what of the future? Are new issues emerging that are of sufficient urgency to compete successfully for public and legislative attention?

No straightforward answer is at hand. It is easier to say what may be theoretically possible in the world of physical sciences than it is to predict the directions that men and their institutions may take. Nonetheless, there are several probable future interactions between nuclear power and U.S. diplomacy and foreign policy. These interactions can be categorized under the headings of nuclear power for U.S. foreign policy, and foreign policy for U.S. nuclear power.

Nuclear Power for U.S. Foreign Policy

Likely issues having to do with nuclear power as an element of U.S. foreign policy for the 1970's include:[364]

SUSTAINING U.S. TECHNOLOGICAL LEADERSHIP IN THE 1970'S

From World War II to Sputnik U.S. world technological leadership went unchallenged and was sustained in large part by advances in nuclear science and technology. Rather than seek to monopolize this leadership, the United States offered and supplied technological assistance to many countries, especially in Europe, to develop their own use of nuclear power. During the late 1960's, U.S. world leadership was challenged by other nations. Looking to the 1970's and to an era of greater peaceful rather than military competition, there are several fundamental issues involving nuclear energy: To what extent should U.S. foreign policy and diplomacy continue to foster commercial use of nuclear power abroad? Can such a policy help enough with future U.S. technological leadership to be worth the effort, or would the required financial and other resources be more profitably dedicated to some other venture? Would the benefits for U.S. technological leadership be more than offset by economic losses through competition from other countries receiving U.S. technological assistance? Most important of all, are there any significant risks and dangers from the standpoint of U.S. national security in continued U.S. support of foreign nuclear power development?

REDUCING EUROPEAN DEPENDENCE UPON IMPORTED ENERGY

Assuming that U.S. foreign policy objectives continue to call for a European community strong enough to withstand pressures from other blocs of nations, and taking into account the still increasing demand of European economies for energy, can development of nuclear power significantly reduce Europe's dependence upon uncertain imports? To what extent should U.S. diplomacy and foreign policy reflect an objective of reducing a potential gap between demand and supply for energy in Europe? In particular, do present arrangements for U.S. technical assistance for nuclear power need updating? What future balance is desirable between a U.S. foreign policy objective of assuring European nations of a reliable, accessible supply of enriched uranium from the United States and a domestic energy policy which might prefer to limit U.S. foreign supply commitments and thus reduce the need to expand U.S. enrichment capacity?

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[364] There is one aspect of national and international development of nuclear power which has not been treated in this case-study, but that should be mentioned. It is the expanding role of multinational corporations in the nuclear industry. Recently major companies of the U.S. nuclear industry have been entering into arrangements with their counterparts in Europe and elsewhere that may presage the penetration of powerful multinational corporations into the world's nuclear market. Such a development could pose problems of national and foreign policy. Multinational corporations in the nuclear field could raise issues of uncontrolled export or transfer of technology, or questions of control over movement of nuclear materials and associated safeguards, or the ability of some government effectively to regulate use of nuclear power in the face of the resources and pressure from such powerful organizations.

CONTROLLING THE POSSIBILITIES FOR PROLIFERATION

It is safe to predict that U.S. foreign policy will continue to emphasize the fostering of world peace by international measures to reduce proliferation of nuclear weapons, particularly into the hands of less stable nations or other organizations. Questions arising out of this policy posture include:

To what extent should the United States support the expansion of the safeguards function of the International Atomic Energy Agency?

How much is it in the U.S. interest for the IAEA to focus upon safeguards in comparison with its other technical assistance functions?

In what way and within what limitations, if any, should the United States fulfill its commitment to place its nuclear industry voluntarily under IAEA safeguards?

To what extent should U.S. foreign policy attempt to extend the safeguards concept to include physical security of nuclear materials, prevention of their theft, and apprehension of thieves?

To what extent should U.S. diplomacy support fulfillment by the nuclear weapons nations of their commitments under the Nonproliferation Treaty to share benefits of nuclear technology with non-nuclear weapons states?

DEMONSTRATING THE PRACTICABILITY OF INSPECTION FOR ARMS CONTROL

U.S. foreign policy supports arms control and disarmament. One critical issue has been that of international inspection to assure the reliability of control. Commercial use of nuclear power in Europe offers useful experience with international inspection. To what extent can this experience be used by the United States in its advocacy of arms control? Would support of IAEA or of Euratom safeguards be more useful in this context? Would U.S. support of Euratom safeguards encourage counterpart safeguards through a regional bloc of nations within the Soviet orbit?

IMPROVING THE U.S. POSITION IN WORLD TRADE

Assuming that economic losses due to competition from foreign countries whose nuclear power development has been assisted by the United States can be avoided, to what extent can further encouragement of commercial nuclear power in Europe, and elsewhere overseas, benefit the U.S. position in world trade? Can export of nuclear power products and services provide the United States with foreign income comparable to that, for example, of aviation exports?

A POTENTIAL LIMITATION UPON NUCLEAR POWER FOR FOREIGN POLICY

The President's energy message of June 1971 clearly anticipated a growing role for nuclear power in the United States. On the other hand, nuclear power has been under continuing attack in the United States during recent years by those critical of its environmental effects and fearful of the potential dangers of its radioactive wastes. What effect this criticism will have upon the future of nuclear power in the United States remains to be seen. Pending the outcome of this controversy, there may be the question of how far U.S. diplomacy should go in further encouraging the use of nuclear power abroad while it is being challenged at home.

Foreign Policy for Nuclear Power

If nuclear power can be used as an element in U.S. foreign policy, then conversely U.S. foreign policy may be turned to the benefit of the domestic nuclear industry. Several issues in this category of foreign policy benefits for the U.S. nuclear industry include:

MAINTAINING THE COMPETITIVE POSITION OF THE U.S. NUCLEAR INDUSTRY IN THE WORLD MARKET

To date, the largest export market for the U.S. nuclear industry has been in Europe. However, as the United Kingdom joins the European Economic Community and Euratom, there is the possibility that this market may wish to favor its own internal nuclear industries. What diplomatic measures and foreign policy decisions, if any, would be appropriate to preserve access of the U.S. nuclear industry to the nuclear market of the European Economic Community?

FURTHER DEVELOPMENT AND DEMONSTRATION OF U.S. NUCLEAR TECHNOLOGY ABROAD

The long-term future of nuclear power will require the commercial use of the breeder reactor. The nuclear industries of the United States and Europe are seeking to complete the development and demonstration of breeder technology. The U.S. nuclear industry has chosen to concentrate its efforts on the liquid metal fast breeder reactor, one of several technological approaches. This decision has provoked the criticism that too much is being risked on the success of one approach. To what extent should U.S. diplomacy and foreign policy seek to encourage European governments and nuclear industries to develop and demonstrate alternatives to the U.S. approach? To what extent could diplomatic and foreign policy measures reduce the barriers to the flow of technical information on breeder technologies from European nuclear industries, keeping in mind that trade secrecy is often applied in Europe at an earlier stage of industrial development than in the United States?

EXPEDITING THE SOLUTION OF ENVIRONMENTAL EFFECTS OF NUCLEAR POWER

Several technological problems for nuclear power technology remain to be solved before large-scale commercial use of nuclear power is likely to occur, namely, improvements in technology for reactor safety, for perpetual storage of radioactive wastes, and for better ways to dissipate or use waste heat from nuclear power plants. To what extent should U.S. foreign policy and diplomacy seek to encourage European nations, individually or through the Common Market, to perform research and development on these problems which would be of benefit to the U.S. nuclear industry?

ESTABLISHMENT OF INTERNATIONAL STANDARDS FOR NUCLEAR POWER

The ability of the U.S. nuclear industry, and for that matter of other technologically intensive U.S. industries, to compete in foreign markets will be affected by the setting of international standards and perhaps international regulations. To what extent should U.S. foreign policy and diplomacy seek to assure a voice for the United States in the setting and application of international standards for the design, construction, and operation of nuclear power plants? Should this concept be encouraged or discouraged? If international standard setting for nuclear power is to be encouraged, what should be the respective roles of the Government and the U.S. nuclear industry in their establishment?

PROTECTING THE U.S. POSITION IN URANIUM ENRICHMENT

Past U.S. policy determinations have judged as advantageous the strong position of the United States as the principal supplier of enriched uranium or enrichment services in the free world market. To what extent should U.S. diplomacy and foreign policy seek to preserve this position? To what extent should the U.S. attempt to prevent, limit, or control the development and use of alternative enrichment technologies that might threaten U.S. facilities with technological obsolescence, or increase the possibilities of proliferation of foreign capabilities to produce nuclear weapons materials?

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APPENDIX 3

International Atomic Energy Agency

INFORMATION CIRCULAR

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THE AGENCY'S SAFEGUARDS SYSTEM (1965, AS PROVISIONALLY EXTENDED IN 1966 AND 1968)

1. The Agency's safeguards system, as approved by the Board of Governors in 1965, and provisionally extended in 1966 and 1968, is set forth in this document for the information of all Members.

2. The development of the system from 1961 onwards has been as follows:

System		Set forth in document
Nature	Name	
The first system	The Agency's Safeguards System (1961)	INFCIRC/26
The 1961 system as extended to cover large reactor facilities	The Agency's Safeguards System (1961, as Extended in 1964)	INFCIRC/26 and Add.1
The revised system	The Agency's Safeguards System (1965)	INFCIRC/66
The revised system with additional provisions for reprocessing plants	The Agency's Safeguards System (1965 as Provisionally Extended in 1966)	INFCIRC/66/Rev.1
The revised system with further additional provisions for safeguarded nuclear material in conversion plants and fabrication plants	The Agency's Safeguards System (1965, as Provisionally Extended in 1966 and 1968)	INFCIRC/66/Rev.2

THE AGENCY'S SAFEGUARDS SYSTEM
(1965, AS PROVISIONALLY EXTENDED IN 1966 AND 1968)

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THE AGENCY'S SAFEGUARDS SYSTEM (1965, AS PROVISIONALLY EXTENDED IN 1966 AND 1968)

I. GENERAL CONSIDERATIONS

A. THE PURPOSE OF THIS DOCUMENT

1. Pursuant to Article II of its Statute the Agency has the task of seeking "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". Inasmuch as the technology of nuclear energy for peaceful purposes is closely coupled with that for the production of materials for nuclear weapons, the same Article of the Statute provides that the Agency "shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose".

2. The principal purpose of the present document is to establish a system of controls to enable the Agency to comply with this statutory obligation with respect to the activities of Member States in the field of the peaceful uses of nuclear energy, as provided in the Statute. The authority to establish such a system is provided by Article III.A.5. of the Statute, which authorizes the Agency to "establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose". This Article further authorizes the Agency to "apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy". Article XII.A sets forth the rights and responsibilities that the Agency is to have, to the extent relevant, with respect to any project or arrangement which it is to safeguard.

3. The principles set forth in this document and the procedures for which it provides are established for the information of Member States, to enable them to determine in advance the circumstances and manner in which the Agency would administer safeguards, and for the guidance of the organs of the Agency itself, to enable the Board and the Director General to determine readily what provisions should be included in agreements relating to safeguards and how to interpret such provisions.

4. Provisions of this document that are relevant to a particular project, arrangement or activity in the field of nuclear energy will only become legally binding upon the entry into force of a *safeguards agreement* 1) and to the extent that they are incorporated therein. Such incorporation may be made by reference.

5. Appropriate provisions of this document may also be incorporated in bilateral or multilateral arrangements between Member States, including all those that provide for the transfer to the Agency of responsibility for administering safeguards. The Agency will not assume such responsibility unless the principles of the safeguards and the procedures to be used are essentially consistent with those set forth in this document.

6. Agreements incorporating provisions from the earlier version of the Agency's safeguards system 2) will continue to be administered in accordance with such provisions, unless all States parties thereto request the Agency to substitute the provisions of the present document.

7. Provisions relating to types of *principal nuclear facilities,* other then *reactors,* which may produce, process or use safeguarded *nuclear material* will be developed as necessary.

8. The principles and procedures set forth in this document shall be subject to periodic review in the light of the further experience gained by the Agency as well as of technological developments.

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1) The use of italics indicates that a term has a specialized meaning in this document and is defined in Part IV.

2) Set forth in documents INFCIRC/26 and Add.1.

B. GENERAL PRINCIPLES OF THE AGENCY'S SAFEGUARDS

The Agency's obligations

9. Bearing in mind Article II of the Statute, the Agency shall implement safeguards in a manner designed to avoid hampering a State's economic or technological development.

10. The safeguards procedures set forth in this document shall be implemented in a manner designed to be consistent with prudent management practices required for the economic and safe conduct of nuclear activities.

11. In no case shall the Agency request a State to stop the construction or operation of any *principal nuclear facility* to which the Agency's safeguards procedures extend, except by explicit decision of the Board

12. The State or States concerned and the Director General shall hold consultations regarding the application of the provisions of the present document.

13. In implementing safeguards, the Agency shall take every precaution to protect commercial and industrial secrets. No member of the Agency's staff shall disclose, except to the Director General and to such other members of the staff as the Director General may authorize to have such information by reason of their official duties in connection with safeguards, any commercial or industrial secret or any other confidential information coming to his knowledge by reason of the implementation of safeguards by the Agency.

14. The Agency shall not publish or communicate to any State, organization or person any information obtained by it in connection with the implementation of safeguards, except that:

(a) Specific information relating to such implementation in a State may be given to the Board and to such Agency staff members as require such knowledge by reason of their official duties in connection with safeguards, but only to the extent necessary for the Agency to fulfil its safeguards responsibilities;

(b) Summarized lists of items being safeguarded by the Agency may be published upon decision of the Board; and

(c) Additional information may be published upon decision of the Board and if all States directly concerned agree.

Principles of implementation

15. The Agency shall implement safeguards in a State if:

(a) The Agency has concluded with the State a *project agreement* under which materials, services, equipment, facilities or information are supplied, and such agreement provides for the application of safeguards; or

(b) The State is a party to a bilateral or multilateral arrangement under which materials, services, equipment, facilities or information are supplied or otherwise transferred, and:
   (i) All the parties to the arrangement have requested the Agency to administer safeguards; and
   (ii) The Agency has concluded the necessary *safeguards agreement* with the State; or

(c) The Agency has been requested by the State to safeguard certain nuclear activities under the latter's jurisdiction, and the Agency has concluded the necessary *safeguards agreement* with the State.

16. In the light of Article XII.A.5 of the Statute, it is desirable that *safeguards agreements* should provide for the continuation of safeguards, subject to the provisions of this document, with respect to produced special fissionable material and to any materials substituted therefor.

17. The principal factors to be considered by the Board in determining the relevance of particular provisions of this document to various types of materials and facilities shall be the form, scope and amount of the assistance supplied, the character of each individual project and the degree to which such assistance could further any military purpose. The related *safeguards agreement* shall take account of all pertinent circumstances at the time of its conclusion.

18. In the event of any non-compliance by a State with a *safeguards agreement,* the Agency may take the measures set forth in Articles XII.A.7 and XII.C of the Statute.

II. CIRCUMSTANCES REQUIRING SAFEGUARDS

A. NUCLEAR MATERIALS SUBJECT TO SAFEGUARDS

19. Except as provided in paragraphs 21 - 28, *nuclear material* shall be subject to the Agency's safeguards if it is being or has been:

(a) Supplied under a *project agreement*; or

(b) Submitted to safeguards under a *safeguards agreement* by the parties to a bilateral or multilateral arrangement; or

(c) *Unilaterally submitted* to safeguards under a *safeguards agreement*; or

(d) Produced, processed or used in a *principal nuclear facility* which has been:

  (i) Supplied wholly or substantially under a *project agreement*; or
  (ii) Submitted to safeguards under a *safeguards agreement* by the parties to a bilateral or multilateral arrangement; or
  (iii) *Unilaterally submitted* to safeguards under a *safeguards agreement*; or

(e) Produced in or by the use of safeguarded *nuclear material*; or

(f) Substituted, pursuant to paragraph 26(d), for safeguarded *nuclear material.*

20. A *principal nuclear facility* shall be considered as substantially supplied under a *project agreement* if the Board has so determined.

B. EXEMPTIONS FROM SAFEGUARDS

General exemptions

21. *Nuclear material* that would otherwise be subject to safeguards shall be exempted from safeguards at the request of the State concerned, provided that the material so exempted in that State may not at any time exceed:

(a) 1 kilogram in total of special fissionable material, which may consist of one or more of the following:

  (i) Plutonium;

(ii) Uranium with an *enrichment* of 0.2 (20 %) and above, taken account of by multiplying its weight by its *enrichment*;

(iii) Uranium with an *enrichment* below 0.2 (20 %) and above that of natural uranium, taken account of by multiplying its weight by five times the square of its *enrichment*;

(b) 10 metric tons in total of natural uranium and depleted uranium with an *enrichment* above 0.005 (0.5 %);

(c) 20 metric tons of depleted uranium with an *enrichment* of 0.005 (0.5 %) or below; and

(d) 20 metric tons of thorium.

Exemptions related to reactors

22. Produced or used *nuclear material* that would otherwise be subject to safeguards pursuant to paragraph 19(d) or (e) shall be exempted from safeguards if:

(a) It is plutonium produced in the fuel of a *reactor* whose rate of production does not exceed 100 grams of plutonium per year; or

(b) It is produced in a *reactor* determined by the Agency to have a maximum calculated power for continuous operation of less than 3 thermal megawatts, or is used in such a *reactor* and would not be subject to safeguards except for such use, provided that the total power of the *reactors* with respect to which these exemptions apply in any State may not exceed 6 thermal megawatts.

23. Produced special fissionable material that would otherwise be subject to safeguards pursuant only to paragraph 19(e) shall in part be exempted from safeguards if it is produced in a *reactor* in which the ratio of fissionable isotopes within safeguarded *nuclear material* to all fissionable isotopes is less than 0.3 (calculated each time any change is made in the loading of the *reactor* and assumed to be maintained until the next such change). Such fraction of the produced material as corresponds to the calculated ratio shall be subject to safeguards.

C. SUSPENSION OF SAFEGUARDS

24. Safeguards with respect to *nuclear material* may be suspended while the material is transferred, under an arrangement or agreement approved by the Agency, for the purpose of processing, reprocessing, testing, research or development, within the State concerned or to any other Member State or to an international organization, provided that the quantities of *nuclear material* with respect to which safeguards are thus suspended in a State may not at any time exceed;

(a) 1 *effective kilogram* of special fissionable material;

(b) 10 metric tons in total of natural uranium and depleted uranium with an *enrichment* above 0.005 (0.5 %);

(c) 20 metric tons of depleted uranium with an *enrichment* of 0.005 (0.5 %) or below; and

(d) 20 metric tons of thorium.

25. Safeguards with respect to *nuclear material* in irradiated fuel which is transferred for the purpose of reprocessing may also be suspended if the State or States concerned have, with the agreement of the Agency, placed under safeguards substitute *nuclear material* in accordance with paragraph 26(d) for the period of suspension. In addition, safeguards with respect to plutonium contained in irradiated fuel which is transferred for the purpose of reprocessing may be suspended for a period not to exceed six

months if the State or States concerned have, with the agreement of the Agency, placed under safeguards a quantity of uranium whose *enrichment* in the isotope uranium-235 is not less than 0.9 (90%) and the uranium-235 content of which is equal in weight to such plutonium. Upon expiration of the said six months or the completion of reprocessing, whichever is earlier, safeguards shall, with the agreement of the Agency, be applied to such plutonium and shall cease to apply to the uranium substituted therefor.

D. TERMINATION OF SAFEGUARDS

26. *Nuclear material* shall no longer be subject to safeguards after:

(a) It has been returned to the State that originally supplied it (whether directly or through the Agency), if it was subject to safeguards only by reason of such supply and if:

- (i) It was not *improved* while under safeguards; or
- (ii) Any special fissionable material that was produced in it under safeguards has been separated out, or safeguards with respect to such produced material have been terminated; or

(b) The Agency has determined that:

- (i) It was subject to safeguards only by reason of its use in a *principal nuclear facility* specified in paragraph 19(d);
- (ii) It has been removed from such facility; and
- (iii) Any special fissionable material that was produced in it under safeguards has been separated out, or safeguards with respect to such produced material have been terminated; or

(c) The Agency has determined that it has been consumed, or has been diluted in such a way that it is no longer usable for any nuclear activity relevant from the point of view of safeguards, or has become practicably irrecoverable; or

(d) The State or States concerned have, with the agreement of the Agency, placed under safeguards, as a substitute, such amount of the same element, not otherwise subject to safeguards, as the Agency has determined contains fissionable isotopes:

- (i) Whose weight (with due allowance for processing losses) is equal to or greater than the weight of the fissionable isotopes of the material with respect to which safeguards are to terminate; and
- (ii) Whose ratio by weight to the total substituted element is similar to or greater than the ratio by weight of the fissionable isotopes of the material with respect to which safeguards are to terminate to the total weight of such material;

provided that the Agency may agree to the substitution of plutonium for uranium-235 contained in uranium whose *enrichment* is not greater than 0.05 (5.0%); or

(e) It has been transferred out of the State under paragraph 28(d), provided that such material shall again be subject to safeguards if it is returned to the State in which the Agency had safeguarded it; or

(f) The conditions specified in the *safeguards agreement*, pursuant to which it was subject to Agency safeguards, no longer apply, by expiration of the agreement or otherwise.

27. If a State wishes to use safeguarded source material for non-nuclear purposes, such as the production of alloys or ceramics, it shall agree with the Agency on the circumstances under which the safeguards on such material may be terminated.

E. TRANSFER OF SAFEGUARDED NUCLEAR MATERIAL OUT OF THE STATE

28. No safeguarded *nuclear material* shall be transferred outside the jurisdiction of the State in which it is being safeguarded until the Agency has satisfied itself that one or more of the following conditions apply:

(a) The material is being returned, under the conditions specified in paragraph 26(a), to the State that originally supplied it; or

(b) The material is being transferred subject to the provisions of paragraph 24 or 25; or

(c) Arrangements have been made by the Agency to safeguard the material in accordance with this document in the State to which it is being transferred; or

(d) The material was not subject to safeguards pursuant to a *project agreement* and will be subject, in the State to which it is being transferred, to safeguards other than those of the Agency but generally consistent with such safeguards and accepted by the Agency.

III. SAFEGUARDS PROCEDURES

A. GENERAL PROCEDURES

Introduction

29. The safeguards procedures set forth below shall be followed, as far as relevant, with respect to safeguarded *nuclear materials,* whether they are being produced, processed or used in any *principal nuclear facility* or are outside any such facility. These procedures also extend to facilities containing or to contain such materials, including *principal nuclear facilities* to which the criteria in paragraph 19(d) apply.

Design review

30. The Agency shall review the design of *principal nuclear facilities,* for the sole purpose of satisfying itself that a facility will permit the effective application of safeguards.

31. The design review of a *principal nuclear facility* shall take place at as early a stage as possible. In particular, such review shall be carried out in the case of:

(a) An Agency project, before the project is approved;

(b) A bilateral or multilateral arrangement under which the responsibility for administering safeguards is to be transferred to the Agency, or an activity *unilaterally submitted* by a State, before the Agency assumes safeguards responsibilities with respect to the facility;

(c) A transfer of safeguarded *nuclear material* to a *principal nuclear facility* whose design has not previously been reviewed, before such transfer takes place; and

(d) A significant modification of a *principal nuclear facility* whose design has previously been reviewed, before such modification is undertaken.

32. To enable the Agency to perform the required design review, the State shall submit to it relevant design information sufficient for the purpose, including information on such basic characteristics of the *principal nuclear facility* as may bear on the Agency's safeguards procedures. The Agency shall require only the minimum amount of information and data consistent with carrying out its responsibility under this section. It shall complete the review promptly after the submission of this information by the State and shall notify the latter of its conclusions without delay.

Records

33. The State shall arrange for the keeping of records with respect to *principal nuclear facilities* and also with respect to all safeguarded *nuclear material* outside such facilities. For this purpose the State and the Agency shall agree on a system of records with respect to each facility and also with respect to such material, on the basis of proposals to be submitted by the State in sufficient time to allow the Agency to review them before the records need to be kept.

34. If the records are not kept in one of the working languages of the Board, the State shall make arrangements to facilitate their examination by inspectors.

35. The records shall consist, as appropriate, of:

(a) Accounting records of all safeguarded *nuclear material*; and

(b) Operating records for *principal nuclear facilities.*

36. All records shall be retained for at least two years.

Reports

GENERAL REQUIREMENTS

37. The State shall submit to the Agency reports with respect to the production, processing and use of safeguarded *nuclear material* in or outside *principal nuclear facilities.* For this purpose the State and the Agency shall agree on a system of reports with respect to each facility and also with respect to safeguarded *nuclear material* outside such facilities, on the basis of proposals to be submitted by the State in sufficient time to allow the Agency to review them before the reports need to be submitted. The reports need include only such information as is relevant for the purpose of safeguards.

38. Unless otherwise provided in the applicable *safeguards agreement,* reports shall be submitted in one of the working languages of the Board.

ROUTINE REPORTS

39. Routine reports shall be based on the records compiled in accordance with paragraphs 33-36 and shall consist, as appropriate, of:

(a) Accounting reports showing the receipt, transfer out, inventory and use of all safeguarded *nuclear material.* The inventory shall indicate the nuclear and chemical composition and physical form of all material and its location on the date of the report; and

(b) Operating reports showing the use that has been made of each *principal nuclear facility* since the last report and, as far as possible, the programme of future work in the period until the next routine report is expected to reach the Agency.

40. The first routine report shall be submitted as soon as:

(a) There is any safeguarded *nuclear material* to be accounted for; or

(b) The *principal nuclear facility* to which it relates is in a condition to operate.

PROGRESS IN CONSTRUCTION

41. The Agency may, if so provided in a *safeguards agreement*, request information as to when particular stages in the construction of a *principal nuclear facility* have been or are to be reached.

SPECIAL REPORTS

42. The State shall report to the Agency without delay:

(a) If any unusual incident occurs involving actual or potential loss or destruction of, or damage to, any safeguarded *nuclear material* or *principal nuclear facility*; or

(b) If there is good reason to believe that safeguarded *nuclear material* is lost or unaccounted for in quantities that exceed the normal operating and handling losses that have been accepted by the Agency as characteristic of the facility.

43. The State shall report to the Agency, as soon as possible, and in any case within two weeks, any transfer not requiring advance notification that will result in a significant change (to be defined by the Agency in agreement with the State) in the quantity of safeguarded *nuclear material* in a facility, or in a complex of facilities considered as a unit for this purpose by agreement with the Agency. Such report shall indicate the amount and nature of the material and its intended use.

AMPLIFICATION OF REPORTS

44. At the Agency's request the State shall submit amplifications or clarifications of any report, in so far as relevant for the purpose of safeguards.

Inspections

GENERAL PROCEDURES

45. The Agency may inspect safeguarded *nuclear materials* and *principal nuclear facilities.*

46. The purpose of safeguards inspections shall be to verify compliance with *safeguards agreements* and to assist States in complying with such agreements and in resolving any questions arising out of the implementation of safeguards.

47. The number, duration and intensity of inspections actually carried out shall be kept to the minimum consistent with the effective implementation of safeguards, and if the Agency considers that the authorized inspections are not all required, fewer shall be carried out.

48. Inspectors shall neither operate any facility themselves nor direct the staff of a facility to carry out any particular operation.

ROUTINE INSPECTIONS

49. Routine inspections may include, as appropriate:

(a) Audit of records and reports;

(b) Verification of the amount of safeguarded *nuclear material* by physical inspection, measurement and sampling;

(c) Examination of *principal nuclear facilities*, including a check of their measuring instruments and operating characteristics; and

(d) Check of the operations carried out at *principal nuclear facilities* and at *research and development facilities* containing safeguarded *nuclear material.*

50. Whenever the Agency has the right of access to a *principal nuclear facility* at all times 3), it may perform inspections of which notice as required by paragraph 4 of the *Inspectors Document* need not be given, in so far as this is necessary for the effective application of safeguards. The actual procedures to implement these provisions shall be agreed upon between the parties concerned in the *safeguards agreement.*

INITIAL INSPECTIONS OF PRINCIPAL NUCLEAR FACILITIES

51. To verify that the construction of a *principal nuclear facility* is in accordance with the design

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3) See para. 57.

reviewed by the Agency, an initial inspection or inspections of the facility may be carried out, if so provided in a *safeguards agreement*:

(a) As soon as possible after the facility has come under Agency safeguards, in the case of a facility already in operation; or

(b) Before the facility starts to operate, in other cases.

52. The measuring instruments and operating characteristics of the facility shall be reviewed to the extent necessary for the purpose of implementing safeguards. Instruments that will be used to obtain data on the *nuclear materials* in the facility may be tested to determine their satisfactory functioning. Such testing may include the observation by inspectors of commissioning or routine tests by the staff of the facility, but shall not hamper or delay the construction, commissioning or normal operation of the facility.

SPECIAL INSPECTIONS

53. The Agency may carry out special inspections if:

(a) The study of a report indicates that such inspection is desirable; or

(b) Any unforeseen circumstance requires immediate action.

The Board shall subsequently be informed of the reasons for and the results of each such inspection.

54. The Agency may also carry out special inspections of substantial amounts of safeguarded *nuclear material* that are to be transferred outside the jurisdiction of the State in which it is being safeguarded, for which purpose the State shall give the Agency sufficient advance notice of any such proposed transfer.

B. SPECIAL PROCEDURES FOR REACTORS

Reports

55. The frequency of submission of routine reports shall be agreed between the Agency and the State, taking into account the frequency established for routine inspections. However, at least two such reports shall be submitted each year and in no case shall more than 12 such reports be required in any year.

Inspections

56. One of the initial inspections of a *reactor* shall if possible be made just before the reactor first reaches criticality.

57. The maximum frequency of routine inspections of a *reactor* and of the safeguarded *nuclear material* in it shall be determined from the following table:

Whichever is the largest of: (a) Facility inventory (including loading); (b) Annual *throughput*; (c) Maximum potential annual production of special fissionable material (*Effective kilograms of nuclear material*)	Maximum number of routine inspections annually
Up to 1	0
More than 1 and up to 5	1
More than 5 and up to 10	2
More than 10 and up to 15	3
More than 15 and up to 20	4
More than 20 and up to 25	5
More than 25 and up to 30	6
More than 30 and up to 35	7
More than 35 and up to 40	8
More than 40 and up to 45	9
More than 45 and up to 50	10
More than 50 and up to 55	11
More than 55 and up to 60	12
More than 60	Right of access at all times

58. The actual frequency of inspection of a *reactor* shall take account of:

(a) Whether the State possesses irradiated-fuel reprocessing facilities;

(b) The nature of the *reactor* ; and

(c) The nature and amount of the *nuclear material* produced or used in the *reactor.*

C. SPECIAL PROCEDURES RELATING TO SAFEGUARDED NUCLEAR MATERIAL OUTSIDE PRINCIPAL NUCLEAR FACILITIES

Nuclear material in research and development facilities

ROUTINE REPORTS

59. Only accounting reports need be submitted in respect of *nuclear material* in *research and development facilities.* The frequency of submission of such routine reports shall be agreed between the Agency and the State, taking into account the frequency established for routine inspections; however, at least one such report shall be submitted each year and in no case shall more than 12 such reports be required in any year.

ROUTINE INSPECTIONS

60. The maximum frequency of routine inspections of safeguarded *nuclear material* in a *research and development facility* shall be that specified in the table in paragraph 57 for the total amount of material in the facility.

Source material in sealed storage

61. The following simplified procedures for safeguarding stockpiled source material shall be applied if a State undertakes to store such material in a sealed storage facility and not to remove it therefrom without previously informing the Agency.

(b) In the case of uranium with an *enrichment* of 0.01 (1 %) and above, its weight in kilograms multiplied by the square of its *enrichment*;

(c) In the case of uranium with an *enrichment* below 0.01 (1 %) and above 0.005 (0.5 %), its weight in kilograms multiplied by 0.0001; and

(d) In the case of depleted uranium with an *enrichment* of 0.005 (0.5 %) or below, and in the case of thorium, its weight in kilograms multiplied by 0.00005.

73. "Enrichment" means the ratio of the combined weight of the isotopes uranium-233 and uranium-235 to that of the total uranium in question.

74. "Improved" means, with respect to *nuclear material,* that either:

(a) The concentration of fissionable isotopes in it has been increased; or

(b) The amount of chemically separable fissionable isotopes in it has been increased; or

(c) Its chemical or physical form has been changed so as to facilitate further use or processing.

75. "Inspector" means an Agency official designated in accordance with the *Inspectors Document.*

76. "Inspectors Document" means the Annex to the Agency's document GC(V)/INF/39.

77. "Nuclear material" means any source or special fissionable material as defined in Article XX of the Statute.

78. "Principal nuclear facility" means a *reactor*, a plant for processing *nuclear material* irradiated in a *reactor*, a plant for separating the isotopes of a *nuclear material*, a plant for processing or fabricating *nuclear material* (excepting a mine or ore-processing plant) or a facility or plant of such other type as may be designated by the Board from time to time, including associated storage facilities.

79. "Project agreement" means a *safeguards agreement* relating to an Agency project and containing provisions as foreseen in Article XI.F.4(b) of the Statute.

80. "Reactor" means any device in which a controlled, self-sustaining fission chain-reaction can be maintained.

81. "Research and development facility" means a facility, other than a *principal nuclear facility,* used for research or development in the field of nuclear energy.

82. "Safeguards agreement" means an agreement between the Agency and one or more Member States which contains an undertaking by one or more of those States not to use certain items in such a way as to further any military purpose and which gives the Agency the right to observe compliance with such undertaking. Such an agreement may concern:

(a) An Agency project;

(b) A bilateral or multilateral arrangement in the field of nuclear energy under which the Agency may be asked to administer safeguards; or

(c) Any of a State's nuclear activities *unilaterally submitted* to Agency safeguards.

83. "Statute" means the Statute of the Agency.

84. "Throughput" means the rate at which *nuclear material* is introduced into a facility operating at full capacity.

85. "Unilaterally submitted" means submitted by a State to Agency safeguards, pursuant to a *safeguards agreement.*

ANNEX I

PROVISIONS FOR REPROCESSING PLANTS

INTRODUCTION

1. The Agency's Safeguards System (1965) is so formulated as to permit application to *principal nuclear facilities* other than *reactors* as foreseen in paragraph 7. This Annex lays down the additional procedures which are applicable to the safeguarding of *reprocessing plants*. However, because of the possible need to revise these procedures in the light of experience, they shall be subject to review at any time and shall in any case be reviewed after two years' experience of their application has been gained.

SPECIAL PROCEDURES

Reports

2. The frequency of submission of routine reports shall be once each calendar month.

Inspections

3. A *reprocessing plant* having an annual *throughput* not exceeding 5 *effective kilograms* of *nuclear material*, and the safeguarded *nuclear material* in it, may be routinely inspected twice a year. A *reprocessing plant* having an annual *throughput* exceeding 5 *effective kilograms* of *nuclear material*, and the safeguarded *nuclear material* in it, may be inspected at all times. The arrangements for inspections set forth in paragraph 50 shall apply to all inspections to be made under this paragraph.1)

4. When a *reprocessing plant* is under Agency safeguards only because it contains safeguarded *nuclear material*, the inspection frequency shall be based on the rate of delivery of safeguarded *nuclear material*.

5. The State and the Agency shall co-operate in making all the necessary arrangements to facilitate the taking, shipping or analysis of samples, due account being taken of the limitations imposed by the characteristics of a plant already in operation when placed under Agency safeguards.

Mixtures of safeguarded and unsafeguarded nuclear material

6. By agreement between the State and the Agency, the following special arrangements may be made in the case of a *reprocessing plant* to which the criteria in paragraph 19(d) do not apply, and in which safeguarded and unsafeguarded *nuclear materials* are present:

(a) Subject to the provisions of sub-paragraph (b) below, the Agency shall restrict its safeguards procedures to the area in which irradiated fuel is stored, until such time as all or any part of such fuel is transferred out of the storage area into other parts of the plant. Safeguards procedures shall cease to apply to the storage area or plant when either contains no safeguarded *nuclear material*; and

(b) Where possible safeguarded *nuclear material* shall be measured and sampled separately from unsafeguarded material, and at as early a stage as possible. Where separate measurement, sampling or processing are not possible, the whole of the material being processed in that *campaign* shall be subject to the safeguards procedures set out in this Annex. At the conclusion of the processing the *nuclear material* that is thereafter to be safeguarded shall be selected by agreement between the State and the Agency from the whole output of the plant resulting from that *campaign*, due account being taken of any processing losses accepted by the Agency.

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1) It is understood that for plants having an annual *throughput* of more than 60 *effective kilograms*, the right of access at all times would normally be implemented by means of continuous inspection.

DEFINITIONS

7. "Reprocessing plant" 2) means a facility to separate irradiated *nuclear materials* and fission products, and includes the facility's head-end treatment section and its associated storage and analytical sections.

8. "Campaign" means the period during which the chemical processing equipment in a *reprocessing plant* is operated between two successive wash-outs of the *nuclear material* present in the equipment.

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2) This term is synonymous with the term "a plant for processing nuclear material irradiated in a reactor" which is used in paragraph 78.

ANNEX II

PROVISIONS FOR SAFEGUARDED NUCLEAR MATERIAL IN CONVERSION PLANTS AND FABRICATION PLANTS

INTRODUCTION

1. The Agency's Safeguards System (1965, as Provisionally Extended in 1966) is so formulated as to permit application to *principal nuclear facilities* other than *reactors* as foreseen in paragraph 7. This Annex lays down the additional procedures which are applicable to safeguarded *nuclear material* in *conversion plants* and *fabrication plants* [1]. However, because of the possible need to revise these procedures in the light of experience, they shall be subject to review at any time and shall in any case be reviewed after two years' experience of their application has been gained.

SPECIAL PROCEDURES

Reports

2. The frequency of submission of routine reports shall be once each calendar month.

Inspections

3. A *conversion plant* or *fabrication plant* to which the criteria in paragraph 19(d) apply and the *nuclear material* in it, may be inspected at all times if the plant inventory at any time, or the annual input, of *nuclear material* exceeds five *effective kilograms*. Where neither the inventory at any time, nor the annual input, exceeds five *effective kilograms* of *nuclear material*, the routine inspections shall not exceed two a year. The arrangements for inspection set forth in paragraph 50 shall apply to all inspections to be made under this paragraph[2].

4. When a *conversion plant* or *fabrication plant* to which the criteria in paragraph 19(d) do not apply contains safeguarded *nuclear material* the frequency of routine inspections shall be based on the inventory at any time and the annual input of safeguarded *nuclear material*. Where the inventory at any time, or the annual input, of safeguarded *nuclear material* exceeds five *effective kilograms* the plant may be inspected at all times. Where neither the inventory at any time, nor the annual input, exceeds five *effective kilograms* of safeguarded *nuclear material* the routine inspections shall not exceed two a year. The arrangements for inspection set forth in paragraph 50 shall apply to all inspections to be made under this paragraph[2].

5. The intensity of inspection of safeguarded *nuclear material* at various steps in a *conversion plant* or *fabrication plant* shall take account of the nature, isotopic composition and amount of safeguarded *nuclear material* in the plant. Safeguards shall be applied in accordance with the general principles set forth in paragraphs 9-14. Emphasis shall be placed on inspection to control uranium of high enrichments and plutonium.

6. Where a plant may handle safeguarded and unsafeguarded *nuclear material*, the State shall notify the Agency in advance of the programme for handling safeguarded batches to enable the Agency to make inspections during these periods, due account being also taken of the arrangements under paragraph 10 below.

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[1] This terminology is intended to be synonymous with the term "a plant for processing or fabricating *nuclear material* (excepting a mine or ore-processing plant") which is used in paragraph 78.

[2] It is understood that for plants having an inventory at any time, or an annual input, of more than 60 *effective kilograms* the right of access at all times would normally be implemented by means of continuous inspection. Where neither the inventory at any time nor the annual input exceeds one *effective kilogram* of *nuclear material* the plant would not normally be subject to routine inspection.

7. The State and the Agency shall co-operate in making all the necessary arrangements to facilitate the preparation of inventories of safeguarded *nuclear material* and the taking, shipping and/or analysis of samples, due account being taken of the limitations imposed by the characteristics of a plant already in operation when placed under Agency safeguards.

Residues, scrap and waste

8. The State shall ensure that safeguarded *nuclear material* contained in residues, scrap or waste created during conversion or fabrication is recovered, as far as is practicable, in its facilities and within a reasonable period of time. If such recovery is not considered practicable by the State, the State and the Agency shall co-operate in making arrangements to account for and dispose of the material.

Safeguarded and unsafeguarded nuclear material

9. By agreement between the State and the Agency, the following special arrangements may be made in the case of a *conversion plant* or a *fabrication plant* to which the criteria in paragraph 19(d) do not apply, and in which safeguarded and unsafeguarded *nuclear material* are both present:

(a) Subject to the provisions of sub-paragraph (b) below, the Agency shall restrict its safeguards procedures to the area in which safeguarded *nuclear material* is stored, until such time as all or any part of such *nuclear material* is transferred out of the storage area into other parts of the plant. Safeguards procedures shall cease to be applied to the storage area or plant when it contains no safeguarded *nuclear material;* and

(b) Where possible, safeguarded *nuclear material* shall be measured and sampled separately from unsafeguarded *nuclear material,* and at as early a stage as possible. Where separate measurement, sampling or processing is not possible, any *nuclear material* containing safeguarded *nuclear material* shall be subject to the safeguards procedures set out in this Annex. At the conclusion of processing, the *nuclear material* that is thereafter to be safeguarded shall be selected, in accordance with paragraph 11 below when applicable, by agreement between the State and the Agency, due account being taken of any processing losses accepted by the Agency.

Blending of nuclear material

10. When safeguarded *nuclear material* is to be blended with either safeguarded or unsafeguarded *nuclear material,* the State shall notify the Agency sufficiently in advance of the programme of blending to enable the Agency to exercise its right to obtain evidence, through inspection of the blending operation or otherwise, that the blending is performed according to the programme.

11. When safeguarded and unsafeguarded *nuclear material* are blended, if the ratio of fissionable isotopes in the safeguarded component going into the blend to all the fissionable isotopes in the blend is 0.3 or greater, and if the concentration of fissionable isotopes in the unsafeguarded *nuclear material* is increased by such blending, then the whole blend shall remain subject to safeguards. In other cases the following procedures shall apply:

(a) Plutonium/plutonium blending. The quantity of the blend that shall continue to be safeguarded shall be such that its weight, when multiplied by the square of the weight fraction of contained fissionable isotopes, is not less than the weight of originally safeguarded plutonium multiplied by the square of the weight fraction of fissionable isotopes therein, provided however that:

(i) In cases where the weight of the whole blend, when multiplied by the square of the weight fraction of contained fissionable isotopes, is less than the weight of originally safeguarded plutonium multiplied by the square of the weight fraction of fissionable isotopes therein, the whole of the blend shall be safeguarded; and

(ii) The number of fissionable atoms in the portion of the blend that shall continue to be under safeguards shall in no case be less than the number of fissionable atoms in the originally safeguarded plutonium;

(b) Uranium/uranium blending. The quantity of the blend that shall continue to be safeguarded shall be such that the number of *effective kilograms* is not less than the number of *effective kilograms* in the originally safeguarded uranium, provided however that:

(i) In cases where the number of *effective kilograms* in the whole blend is less than in the safeguarded uranium, the whole of the blend shall be safeguarded; and

(ii) The number of fissionable atoms in the portion of the blend that shall continue to be under safeguards shall in no case be less than the number of fissionable atoms in the originally safeguarded uranium;

(c) Uranium/plutonium blending. The whole of the resultant blend shall be safeguarded until the uranium and the plutonium constituents are separated. After separation of the uranium and plutonium, safeguards shall apply to the originally safeguarded component; and

(d) Due account shall be taken of any processing losses agreed upon between the State and the Agency.

DEFINITIONS

12. "Conversion plant" means a facility (excepting a mine or ore-processing plant) to *improve* unirradiated *nuclear material*, or irradiated *nuclear material* that has been separated from fission products, by changing its chemical or physical form so as to facilitate further use or processing. The term *conversion plant* includes the facility's storage and analytical sections. The term does not include a plant intended for separating the isotopes of a *nuclear material*.

13. "Fabrication plant" means a plant to manufacture fuel elements or other components containing *nuclear material* and includes the plant's storage and analytical sections.

APPENDIX 4

THE STRUCTURE AND CONTENT OF AGREEMENTS BETWEEN THE AGENCY AND STATES REQUIRED IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS

The Board of Governors has requested
the Director General
to use the material reproduced in this booklet
as the basis for negotiating safeguards agreements
between the Agency
and non-nuclear-weapon States
party to the Treaty on the Non-Proliferation
of Nuclear Weapons.

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PART I

BASIC UNDERTAKING

1. The Agreement should contain, in accordance with Article III.1 of the Treaty on the Non-Proliferation of Nuclear Weapons[1], an undertaking by the State to accept safeguards, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

APPLICATION OF SAFEGUARDS

2. The Agreement should provide for the Agency's right and obligation to ensure that safeguards will be applied, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

CO-OPERATION BETWEEN THE AGENCY AND THE STATE

3. The Agreement should provide that the Agency and the State shall co-operate to facilitate the implementation of the safeguards provided for therein.

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1) Reproduced in document INFCIRC/140.

IMPLEMENTATION OF SAFEGUARDS

4. The Agreement should provide that safeguards shall be implemented in a manner designed:

   (a) To avoid hampering the economic and technological development of the State or international co-operation in the field of peaceful nuclear activities, including international exchange of *nuclear material*[2];

   (b) To avoid undue interference in the State's peaceful nuclear activities, and in particular in the operation of *facilities;* and

   (c) To be consistent with prudent management practices required for the economic and safe conduct of nuclear activities.

5. The Agreement should provide that the Agency shall take every precaution to protect commercial and industrial secrets and other confidential information coming to its knowledge in the implementation of the Agreement. The Agency shall not publish or communicate to any State, organization or person any information obtained by it in connection with the implementation of the Agreement, except that specific information relating to such implementation in the State may be given to the Board of Governors and to such Agency staff members as require such knowledge by reason of their official duties in connection with safeguards, but only to the extent necessary for the Agency to fulfil its responsibilities in implementing the Agreement. Summarized information on *nuclear material* being safeguarded by the Agency under the Agreement may be published upon decision of the Board if the States directly concerned agree.

6. The Agreement should provide that in implementing safeguards pursuant thereto the Agency shall take full account of technological developments in the field of safeguards, and shall make every effort to ensure optimum cost-effectiveness and the application of the principle of safeguarding effectively the flow of *nuclear material* subject to safeguards under the Agreement by use of instruments and other techniques at certain *strategic points* to the extent that present or future technology permits. In order to ensure optimum cost-effectiveness, use should be made, for example, of such means as:

   (a) Containment as a means of defining *material balance areas* for accounting purposes;

   (b) Statistical techniques and random sampling in evaluating the flow of *nuclear material;* and

   (c) Concentration of verification procedures on those stages in the nuclear fuel cycle involving the production, processing, use or storage of *nuclear material* from which nuclear weapons or other nuclear explosive devices could readily be made, and minimization of verification procedures in respect of other *nuclear material,* on condition that this does not hamper the Agency in applying safeguards under the Agreement.

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2) Terms in italics have a specialized meaning, which is defined in paragraphs 98—116 below.

NATIONAL SYSTEM OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIAL

7. The Agreement should provide that the State shall establish and maintain a system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement, and that such safeguards shall be applied in such a manner as to enable the Agency to verify, in ascertaining that there has been no diversion of *nuclear material* from peaceful uses to nuclear weapons or other nuclear explosive devices, findings of the State's system. The Agency's verification shall include, inter alia, independent measurements and observations conducted by the Agency in accordance with the procedures specified in Part II below. The Agency, in its verification, shall take due account of the technical effectiveness of the State's system.

PROVISION OF INFORMATION TO THE AGENCY

8. The Agreement should provide that to ensure the effective implementation of safeguards thereunder the Agency shall be provided, in accordance with the provisions set out in Part II below, with information concerning *nuclear material* subject to safeguards under the Agreement and the features of *facilities* relevant to safeguarding such material. The Agency shall require only the minimum amount of information and data consistent with carrying out its responsibilities under the Agreement. Information pertaining to *facilities* shall be the minimum necessary for safeguarding *nuclear material* subject to safeguards under the Agreement. In examining design information, the Agency shall, at the request of the State, be prepared to examine on premises of the State design information which the State regards as being of particular sensitivity. Such information would not have to be physically transmitted to the Agency provided that it remained available for ready further examination by the Agency on premises of the State.

AGENCY INSPECTORS

9. The Agreement should provide that the State shall take the necessary steps to ensure that Agency inspectors can effectively discharge their functions under the Agreement. The Agency shall secure the consent of the State to the designation of Agency inspectors to that State. If the State, either upon proposal of a designation or at any other time after a designation has been made, objects to the designation, the Agency shall propose to the State an alternative designation or designations. The repeated refusal of a State to accept the designation of Agency inspectors which would impede the inspections conducted under the Agreement would be considered by the Board upon referral by the Director General with a view to appropriate action. The visits and activities of Agency inspectors shall be so arranged as to reduce to a

minimum the possible inconvenience and disturbance to the State and to the peaceful nuclear activities inspected, as well as to ensure protection of industrial secrets or any other confidential information coming to the inspectors' knowledge.

PRIVILEGES AND IMMUNITIES

10. The Agreement should specify the privileges and immunities which shall be granted to the Agency and its staff in respect of their functions under the Agreement. In the case of a State party to the Agreement on the Privileges and Immunities of the Agency 3), the provisions thereof, as in force for such State, shall apply. In the case of other States, the privileges and immunities granted should be such as to ensure that:

(a) The Agency and its staff will be in a position to discharge their functions under the Agreement effectively; and

(b) No such State will be placed thereby in a more favourable position than States party to the Agreement on the Privileges and Immunities of the Agency.

TERMINATION OF SAFEGUARDS

Consumption or dilution of nuclear material

11. The Agreement should provide that safeguards shall terminate on *nuclear material* subject to safeguards thereunder upon determination by the Agency that it has been consumed, or has been diluted in such a way that it is no longer usable for any nuclear activity relevant from the point of view of safeguards, or has become practicably irrecoverable.

Transfer of nuclear material out of the State

12. The Agreement should provide, with respect to *nuclear material* subject to safeguards thereunder, for notification of transfers of such material out of the State, in accordance with the provisions set out in paragraphs 92—94 below. The Agency shall terminate safeguards under the Agreement on *nuclear material* when the recipient State has assumed responsibility therefor, as provided for in paragraph 91. The Agency shall maintain records indicating each transfer and, where applicable, the re-application of safeguards to the transferred *nuclear material.*

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3) Reproduced in document INFCIRC/9/Rev. 2.

Provisions relating to nuclear material to be used in non-nuclear activities

13. The Agreement should provide that if the State wishes to use *nuclear material* subject to safeguards thereunder in non-nuclear activities, such as the production of alloys or ceramics, it shall agree with the Agency on the circumstances under which the safeguards on such *nuclear material* may be terminated.

NON-APPLICATION OF SAFEGUARDS TO NUCLEAR MATERIAL TO BE USED IN NON-PEACEFUL ACTIVITIES

14. The Agreement should provide that if the State intends to exercise its discretion to use *nuclear material* which is required to be safeguarded thereunder in a nuclear activity which does not require the application of safeguards under the Agreement, the following procedures will apply:

(a) The State shall inform the Agency of the activity, making it clear:

(i) That the use of the *nuclear material* in a non-proscribed military activity will not be in conflict with an undertaking the State may have given and in respect of which Agency safeguards apply, that the *nuclear material* will be used only in a peaceful nuclear activity; and

(ii) That during the period of non-application of safeguards the *nuclear material* will not be used for the production of nuclear weapons or other nuclear explosive devices;

(b) The State and the Agency shall make an arrangement so that, only while the *nuclear material* is in such an activity, the safeguards provided for in the Agreement will not be applied. The arrangement shall identify, to the extent possible, the period or circumstances during which safeguards will not be applied. In any event, the safeguards provided for in the Agreement shall again apply as soon as the *nuclear material* is reintroduced into a peaceful nuclear activity. The Agency shall be kept informed of the total quantity and composition of such unsafeguarded *nuclear material* in the State and of any exports of such material; and

(c) Each arrangement shall be made in agreement with the Agency. The Agency's agreement shall be given as promptly as possible; it shall only relate to the temporal and procedural provisions, reporting arrangements, etc., but shall not involve any approval or classified knowledge of the military activity or relate to the use of the *nuclear material* therein.

FINANCE

15. The Agreement should contain one of the following sets of provisions:

(a) An agreement with a Member of the Agency should provide that each party thereto shall bear the expenses it incurs in implementing its responsibilities thereunder. However, if the State or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the Agency, the Agency shall reimburse such expenses provided that it has agreed in advance to do so. In any case the Agency shall bear the cost of any additional measuring or sampling which inspectors may request; or

(b) An agreement with a party not a Member of the Agency should in application of the provisions of Article XIV.C of the Statute, provide that the party shall reimburse fully to the Agency the safeguards expenses the Agency incurs thereunder. However, if the party or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the Agency, the Agency shall reimburse such expenses provided that it has agreed in advance to do so.

THIRD PARTY LIABILITY FOR NUCLEAR DAMAGE

16. The Agreement should provide that the State shall ensure that any protection against third party liability in respect of nuclear damage, including any insurance or other financial security, which may be available under its laws or regulations shall apply to the Agency and its officials for the purpose of the implementation of the Agreement, in the same way as that protection applies to nationals of the State.

INTERNATIONAL RESPONSIBILITY

17. The Agreement should provide that any claim by one party thereto against the other in respect of any damage, other than damage arising out of a nuclear incident, resulting from the implementation of safeguards under the Agreement, shall be settled in accordance with international law.

MEASURES IN RELATION TO VERIFICATION OF NON-DIVERSION

18. The Agreement should provide that if the Board, upon report of the Director General, decides that an action by the State is essential and urgent in order to ensure verification that *nuclear material* subject to safeguards under the Agreement is not diverted to nuclear weapons or other nuclear explosive devices the Board shall be able to call upon the State to take the required action without delay, irrespective of whether procedures for the settlement of a dispute have been invoked.

19. The Agreement should provide that if the Board upon examination of relevant information reported to it by the Director General finds that the

Agency is not able to verify that there has been no diversion of *nuclear material* required to be safeguarded under the Agreement to nuclear weapons or other nuclear explosive devices, it may make the reports provided for in paragraph C of Article XII of the Statute and may also take, where applicable, the other measures provided for in that paragraph. In taking such action the Board shall take account of the degree of assurance provided by the safeguards measures that have been applied and shall afford the State every reasonable opportunity to furnish the Board with any necessary reassurance.

INTERPRETATION AND APPLICATION OF THE AGREEMENT AND SETTLEMENT OF DISPUTES

20. The Agreement should provide that the parties thereto shall, at the request of either, consult about any question arising out of the interpretation or application thereof.

21. The Agreement should provide that the State shall have the right to request that any question arising out of the interpretation or application thereof be considered by the Board ; and that the State shall be invited by the Board to participate in the discussion of any such question by the Board.

22. The Agreement should provide that any dispute arising out of the interpretation or application thereof except a dispute with regard to a finding by the Board under paragraph 19 above or an action taken by the Board pursuant to such a finding which is not settled by negotiation or another procedure agreed to by the parties should, on the request of either party, be submitted to an arbitral tribunal composed as follows: each party would designate one arbitrator, and the two arbitrators so designated would elect a third, who would be the Chairman. If, within 30 days of the request for arbitration, either party has not designated an arbitrator, either party to the dispute may request the President of the International Court of Justice to appoint an arbitrator. The same procedure would apply if, within 30 days of the designation or appointment of the second arbitrator, the third arbitrator had not been elected. A majority of the members of the arbitral tribunal would constitute a quorum, and all decisions would require the concurrence of two arbitrators. The arbitral procedure would be fixed by the tribunal. The decisions of the tribunal would be binding on both parties.

FINAL CLAUSES

Amendment of the Agreement

23. The Agreement should provide that the parties thereto shall, at the request of either of them, consult each other on amendment of the Agreement. All amendments shall require the agreement of both parties. It might additionally be provided, if convenient to the State, that the agreement of the

parties on amendments to Part II of the Agreement could be achieved by recourse to a simplified procedure. The Director General shall promptly inform all Member States of any amendment to the Agreement.

Suspension of application of Agency safeguards under other agreements

24. Where applicable and where the State desires such a provision to appear, the Agreement should provide that the application of Agency safeguards in the State under other safeguards agreements with the Agency shall be suspended while the Agreement is in force. If the State has received assistance from the Agency for a project, the State's undertaking in the Project Agreement not to use items subject thereto in such a way as to further any military purpose shall continue to apply.

Entry into force and duration

25. The Agreement should provide that it shall enter into force on the date on which the Agency receives from the State written notification that the statutory and constitutional requirements for entry into force have been met. The Director General shall promptly inform all Member States of the entry into force.

26. The Agreement should provide for it to remain in force as long as the State is party to the Treaty on the Non-Proliferation of Nuclear Weapons 1).

PART II

INTRODUCTION

27. The Agreement should provide that the purpose of Part II thereof is to specify the procedures to be applied for the implementation of the safeguards provisions of Part I.

OBJECTIVE OF SAFEGUARDS

28. The Agreement should provide that the objective of safeguards is the timely detection of diversion of significant quantities of *nuclear material* from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.

29. To this end the Agreement should provide for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures.

30. The Agreement should provide that the technical conclusion of the Agency's verification activities shall be a statement, in respect of each *material balance area,* of the amount of *material unaccounted for* over a specific period, giving the limits of accuracy of the amounts stated.

NATIONAL SYSTEM OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIAL

31. The Agreement should provide that pursuant to paragraph 7 above the Agency, in carrying out its verification activities, shall make full use of the State's system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement, and shall avoid unnecessary duplication of the State's accounting and control activities.

32. The Agreement should provide that the State's system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement

shall be based on a structure of material balance areas, and shall make provision as appropriate and specified in the Subsidiary Arrangements for the establishment of such measures as:

(a) A measurement system for the determination of the quantities of *nuclear material* received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory;

(b) The evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty;

(c) Procedures for identifying, reviewing and evaluating differences in shipper/receiver measurements;

(d) Procedures for taking a *physical inventory;*

(e) Procedures for the evaluation of accumulations of unmeasured inventory and unmeasured losses;

(f) A system of records and reports showing, for each *material balance area,* the inventory of *nuclear material* and the changes in that inventory including receipts into and transfers out of the *material balance area;*

(g) Provisions to ensure that the accounting procedures and arrangements are being operated correctly; and

(h) Procedures for the submission of reports to the Agency in accordance with paragraphs 59—69 below.

STARTING POINT OF SAFEGUARDS

33. The Agreement should provide that safeguards shall not apply thereunder to material in mining or ore processing activities.

34. The Agreement should provide that:

(a) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in sub-paragraph (c) below is directly or indirectly exported to a non-nuclear-weapon State, the State shall inform the Agency of its quantity, composition and destination, unless the material is exported for specifically non-nuclear purposes;

(b) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in sub-paragraph (c) below is imported, the State shall inform the Agency of its quantity and composition, unless the material is imported for specifically non-nuclear purposes; and

(c) When any *nuclear material* of a composition and purity suitable for fuel fabrication or for being isotopically enriched leaves the plant or the process stage in which it has been produced, or when such *nuclear material,* or any other *nuclear material* produced at a later stage in the nuclear fuel cycle, is imported into the State, the *nuclear material* shall become subject to the other safeguards procedures specified in the Agreement.

TERMINATION OF SAFEGUARDS

35. The Agreement should provide that safeguards shall terminate on *nuclear material* subject to safeguards thereunder under the conditions set forth in paragraph 11 above. Where the conditions of that paragraph are not met, but the State considers that the recovery of safeguarded *nuclear material* from residues is not for the time being practicable or desirable, the Agency and the State shall consult on the appropriate safeguards measures to be applied. It should further be provided that safeguards shall terminate on *nuclear material* subject to safeguards under the Agreement under the conditions set forth in paragraph 13 above, provided that the State and the Agency agree that such *nuclear material* is practicably irrecoverable.

EXEMPTIONS FROM SAFEGUARDS

36. The Agreement should provide that the Agency shall, at the request of the State, exempt *nuclear material* from safeguards, as follows:

(a) Special fissionable material, when it is used in gram quantities or less as a sensing component in instruments;

(b) *Nuclear material,* when it is used in non-nuclear activities in accordance with paragraph 13 above, if such *nuclear material* is recoverable; and

(c) Plutonium with an isotopic concentration of plutonium-238 exceeding 80%.

37. The Agreement should provide that *nuclear material* that would otherwise be subject to safeguards shall be exempted from safeguards at the request of the State, provided that *nuclear material* so exempted in the State may not at any time exceed:

(a) One kilogram in total of special fissionable material, which may consist of one of more of the following:

(i) Plutonium;

(ii) Uranium with an *enrichment* of 0.2 (20%) and above, taken account of by multiplying its weight by its *enrichment;* and

(iii) Uranium with an *enrichment* below 0.2 (20%) and above that of natural uranium, taken account of by multiplying its weight by five times the square of its *enrichment;*

(b) Ten metric tons in total of natural uranium and depleted uranium with an *enrichment* above 0.005 (0.5%);

(c) Twenty metric tons of depleted uranium with an *enrichment* of 0.005 (0.5%) or below; and

(d) Twenty metric tons of thorium;

or such greater amounts as may be specified by the Board of Governors for uniform application.

38. The Agreement should provide that if exempted *nuclear material* is to be

processed or stored together with safeguarded *nuclear material,* provision should be made for the re-application of safeguards thereto.

SUBSIDIARY ARRANGEMENTS

39. The Agreement should provide that the Agency and the State shall make Subsidiary Arrangements which shall specify in detail, to the extent necessary to permit the Agency to fulfil its responsibilities under the Agreement in an effective and efficient manner, how the procedures laid down in the Agreement are to be applied. Provision should be made for the possibility of an extension or change of the Subsidiary Arrangements by agreement between the Agency and the State without amendment of the Agreement.

40. It should be provided that the Subsidiary Arrangements shall enter into force at the same time as, or as soon as possible after, the entry into force of the Agreement. The State and the Agency shall make every effort to achieve their entry into force within 90 days of the entry into force of the Agreement, a later date being acceptable only with the agreement of both parties. The State shall provide the Agency promptly with the information required for completing the Subsidiary Arrangements. The Agreement should also provide that, upon its entry into force, the Agency shall be entitled to apply the procedures laid down therein in respect of the *nuclear material* listed in the inventory provided for in paragraph 41 below.

INVENTORY

41. The Agreement should provide that, on the basis of the initial report referred to in paragraph 62 below, the Agency shall establish a unified inventory of all *nuclear material* in the State subject to safeguards under the Agreement, irrespective of its origin, and maintain this inventory on the basis of subsequent reports and of the results of its verification activities. Copies of the inventory shall be made available to the State at agreed intervals.

DESIGN INFORMATION

General

42. Pursuant to paragraph 8 above, the Agreement should stipulate that design information in respect of existing *facilities* shall be provided to the Agency during the discussion of the Subsidiary Arrangements, and that the time limits for the provision of such information in respect of new *facilities* shall be specified in the Subsidiary Arrangements. It should further be stipulated that such information shall be provided as early as possible before *nuclear material* is introduced into a new *facility.*

43. The Agreement should specify that the design information in respect of each *facility* to be made available to the Agency shall include, when applicable:

(a) Identification of the *facility,* stating its general character, purpose, nominal capacity and geographic location, and the name and address to be used for routine business purposes;

(b) Description of the general arrangement of the *facility* with reference, to the extent feasible, to the form, location and flow of *nuclear material* and to the general layout of important items of equipment which use, produce or process *nuclear material;*

(c) Description of features of the *facility* relating to material accountancy, containment and surveillance; and

(d) Description of the existing and proposed procedures at the *facility* for *nuclear material* accountancy and control, with special reference to *material balance areas* established by the operator, measurements of flow and procedures for *physical inventory* taking.

44. The Agreement should further provide that other information relevant to the application of safeguards shall be made available to the Agency in respect of each *facility,* in particular on organizational responsibility for material accountancy and control. It should also be provided that the State shall make available to the Agency supplementary information on the health and safety procedures which the Agency shall observe and with which the inspectors shall comply at the *facility.*

45. The Agreement should stipulate that design information in respect of a modification relevant for safeguards purposes shall be provided for examination sufficiently in advance for the safeguards procedures to be adjusted when necessary.

Purposes of examination of design information

46. The Agreement should provide that the design information made available to the Agency shall be used for the following purposes:

(a) To identify the features of *facilities* and *nuclear material* relevant to the application of safeguards to *nuclear material* in sufficient detail to facilitate verification;

(b) To determine *material balance areas* to be used for Agency accounting purposes and to select those *strategic points* which are *key measurement points* and which will be used to determine the *nuclear material* flows and inventories; in determining such *material balance areas* the Agency shall, inter alia, use the following criteria:

(i) The size of the *material balance area* should be related to the accuracy with which the material balance can be established;

(ii) In determining the *material balance area* advantage should be taken of any opportunity to use containment and surveillance to help ensure the completeness of flow measurements and thereby simplify the application of safeguards and concentrate measurement efforts at *key measurement points;*

(iii) A number of *material balance areas* in use at a *facility* or at distinct sites may be combined in one *material balance area* to be used for Agency accounting purposes when the Agency determines that this is consistent with its verification requirements; and

(iv) If the State so requests, a special *material balance area* around a process step involving commercially sensitive information may be established ;

(c) To establish the nominal timing and procedures for taking of *physical inventory* for Agency accounting purposes;

(d) To establish the records and reports requirements and records evaluation procedures;

(e) To establish requirements and procedures for verification of the quantity and location of *nuclear material;* and

(f) To select appropriate combinations of containment and surveillance methods and techniques and the *strategic points* at which they are to be applied.

It should further be provided that the results of the examination of the design information shall be included in the Subsidiary Arrangements.

Re-examination of design information

47. The Agreement should provide that design information shall be re-examined in the light of changes in operating conditions, of developments in safeguards technology or of experience in the application of verification procedures, with a view to modifying the action the Agency has taken pursuant to paragraph 46 above.

Verification of design information

48. The Agreement should provide that the Agency, in co-operation with the State, may send inspectors to *facilities* to verify the design information provided to the Agency pursuant to paragraphs 42—45 above for the purposes stated in paragraph 46.

INFORMATION IN RESPECT OF NUCLEAR MATERIAL OUTSIDE FACILITIES

49. The Agreement should provide that the following information concerning *nuclear material* customarily used outside *facilities* shall be provided as applicable to the Agency:

(a) General description of the use of the *nuclear material,* its geographic location, and the user's name and address for routine business purposes; and

(b) General description of the existing and proposed procedures for *nuclear material* accountancy and control, including organizational responsibility for material accountancy and control.

The Agreement should further provide that the Agency shall be informed on a timely basis of any change in the information provided to it under this paragraph.

50. The Agreement should provide that the information made available to the Agency in respect of *nuclear material* customarily used outside *facilities* may be used, to the extent relevant, for the purposes set out in subparagraphs 46(b)—(f) above.

RECORDS SYSTEM

General

51. The Agreement should provide that in establishing a national system of accounting for and control of *nuclear material* as referred to in paragraph 7 above, the State shall arrange that records are kept in respect of each *material balance area.* Provision should also be made that the Subsidiary Arrangements shall describe the records to be kept in respect of each *material balance area.*

52. The Agreement should provide that the State shall make arrangements to facilitate the examination of records by inspectors, particularly if the records are not kept in English, French, Russian or Spanish.

53. The Agreement should provide that the records shall be retained for at least five years.

54. The Agreement should provide that the records shall consist, as appropriate, of:

(a) Accounting records of all *nuclear material* subject to safeguards under the Agreement; and

(b) Operating records for *facilities* containing such *nuclear material.*

55. The Agreement should provide that the system of measurements on which the records used for the preparation of reports are based shall either conform to the latest international standards or be equivalent in quality to such standards.

Accounting records

56. The Agreement should provide that the accounting records shall set forth the following in respect of each *material balance area:*

(a) All *inventory changes,* so as to permit a determination of the *book inventory* at any time;

(b) All measurement results that are used for determination of the *physical inventory;* and

(c) All *adjustments* and *corrections* that have been made in respect of *inventory changes, book inventories* and *physical inventories.*

57. The Agreement should provide that for all *inventory changes* and *physical inventories* the records shall show, in respect of each *batch* of *nuclear material:* material identification, *batch data* and *source data.* Provision should further be included that records shall account for uranium, thorium and plutonium separately in each *batch* of *nuclear material.* Furthermore, the date of the *inventory change* and, when appropriate, the originating *material balance area* and the receiving *material balance area* or the recipient, shall be indicated for each *inventory change.*

Operating records

58. The Agreement should provide that the operating records shall set forth as appropriate in respect of each *material balance area:*

(a) Those operating data which are used to establish changes in the quantities and composition of *nuclear material;*
(b) The data obtained from the calibration of tanks and instruments and from sampling and analyses, the procedures to control the quality of measurements and the derived estimates of random and systematic error;
(c) The description of the sequence of the actions taken in preparing for, and in taking, a *physical inventory,* in order to ensure that it is correct and complete; and
(d) The description of the actions taken in order to ascertain the cause and magnitude of any accidental or unmeasured loss that might occur.

REPORTS SYSTEM

General

59. The Agreement should specify that the State shall provide the Agency with reports as detailed in paragraphs 60—69 below in respect of *nuclear material* subject to safeguards thereunder.

60. The Agreement should provide that reports shall be made in English, French, Russian or Spanish, except as otherwise specified in the Subsidiary Arangements.

61. The Agreement should provide that reports shall be based on the records kept in accordance with paragraphs 51—58 above and shall consist, as appropriate, of accounting reports and special reports.

Accounting reports

62. The Agreement should stipulate that the Agency shall be provided with an initial report on all *nuclear material* which is to be subject to safeguards

thereunder. It should also be provided that the initial report shall be dispatched by the State to the Agency within 30 days of the last day of the calendar month in which the Agreement enters into force, and shall reflect the situation as of the last day of that month.

63. The Agreement should stipulate that for each *material balance area* the State shall provide the Agency with the following accounting reports:

(a) *Inventory change* reports showing changes in the inventory of *nuclear material.* The reports shall be dispatched as soon as possible and in any event within 30 days after the end of the month in which the *inventory changes* occurred or were established; and

(b) Material balance reports showing the material balance based on a *physical inventory* of *nuclear material* actually present in the *material balance area.* The reports shall be dispatched as soon as possible and in any event within 30 days after the *physical inventory* has been taken.

The reports shall be based on data available as of the date of reporting and may be corrected at a later date as required.

64. The Agreement should provide that *inventory change* reports shall specify identification and *batch data* for each *batch* of *nuclear material,* the date of the *inventory change* and, as appropriate, the originating *material balance area* and the receiving *material balance area* or the recipient. These reports shall be accompanied by concise notes:

(a) Explaining the *inventory changes,* on the basis of the operating data contained in the operating records provided for under sub-paragraph 58(a) above; and

(b) Describing, as specified in the Subsidiary Arrangements, the anticipated operational programme, particularly the taking of a *physical inventory.*

65. The Agreement should provide that the State shall report each *inventory change, adjustment* and *correction* either periodically in a consolidated list or individually. The *inventory changes* shall be reported in terms of *batches;* small amounts, such as analytical samples, as specified in the Subsidiary Arrangements, may be combined and reported as one *inventory change.*

66. The Agreement should stipulate that the Agency shall provide the State with semi-annual statements of *book inventory* of *nuclear material* subject to safeguards, for each *material balance area,* as based on the *inventory change* reports for the period covered by each such statement.

67. The Agreement should specify that the material balance reports shall include the following entries, unless otherwise agreed by the Agency and the State:

(a) Beginning *physical inventory;*
(b) *Inventory changes* (first increases, then decreases);
(c) Ending *book inventory;*
(d) *Shipper/receiver differences;*
(e) Adjusted ending *book inventory;*
(f) Ending *physical inventory;* and
(g) *Material unaccounted for.*

A statement of the *physical inventory,* listing all *batches* separately and specifying material identification and *batch data* for each *batch,* shall be attached to each material balance report.

Special reports

68. The Agreement should provide that the State shall make special reports without delay:

(a) If any unusual incident or circumstances lead the State to believe that there is or may have been loss of *nuclear material* that exceeds the limits to be specified for this purpose in the Subsidiary Arrangements; or

(b) If the containment has unexpectedly changed from that specified in the Subsidiary Arrangements to the extent that unauthorized removal of *nuclear material* has become possible.

Amplification and clarification of reports

69. The Agreement should provide that at the Agency's request the State shall supply amplifications or clarifications of any report, in so far as relevant for the purpose of safeguards.

INSPECTIONS

General

70. The Agreement should stipulate that the Agency shall have the right to make inspections as provided for in paragraphs 71—82 below.

Purposes of inspections

71. The Agreement should provide that the Agency may make ad hoc inspections in order to:

(a) Verify the information contained in the initial report on the *nuclear material* subject to safeguards under the Agreement;

(b) Identify and verify changes in the situation which have occurred since the date of the initial report; and

(c) Identify, and if possible verify the quantity and composition of, *nuclear material* in accordance with paragraphs 93 and 96 below, before its transfer out of or upon its transfer into the State.

72. The Agreement should provide that the Agency may make routine inspections in order to:

(a) Verify that reports are consistent with records;

(b) Verify the location, identity, quantity and composition of all *nuclear* *material* subject to safeguards under the Agreement; and

(c) Verify information on the possible causes of *material unaccounted for, shipper/receiver differences* and uncertainties in the *book inventory.*

73. The Agreement should provide that the Agency may make special inspections subject to the procedures laid down in paragraph 77 below:

(a) In order to verify the information contained in special reports; or

(b) If the Agency considers that information made available by the State, including explanations from the State and information obtained from routine inspections, is not adequate for the Agency to fulfil its responsibilities under the Agreement.

An inspection shall be deemed to be special when it is either additional to the routine inspection effort provided for in paragraphs 78—82 below, or involves access to information or locations in addition to the access specified in paragraph 76 for ad hoc and routine inspections, or both.

Scope of inspections

74. The Agreement should provide that for the purposes stated in paragraphs 71—73 above the Agency may:

(a) Examine the records kept pursuant to paragraphs 51—58;

(b) Make independent measurements of all *nuclear material* subject to safeguards under the Agreement;

(c) Verify the functioning and calibration of instruments and other measuring and control equipment;

(d) Apply and make use of surveillance and containment measures; and

(e) Use other objective methods which have been demonstrated to be technically feasible.

75. It should further be provided that within the scope of paragraph 74 above the Agency shall be enabled:

(a) To observe that samples at *key measurement points* for material balance accounting are taken in accordance with procedures which produce representative samples, to observe the treatment and analysis of the samples and to obtain duplicates of such samples;

(b) To observe that the measurements of *nuclear material* at *key measurement points* for material balance accounting are representative, and to observe the calibration of the instruments and equipment involved;

(c) To make arrangements with the State that, if necessary:

(i) Additional measurements are made and additional samples taken for the Agency's use;

(ii) The Agency's standard analytical samples are analysed;

(iii) Appropriate absolute standards are used in calibrating instruments and other equipment; and

(iv) Other calibrations are carried out;

(d) To arrange to use its own equipment for independent measurement and surveillance, and if so agreed and specified in the Subsidiary Arrangements, to arrange to install such equipment;

(e) To apply its seals and other identifying and tamper-indicating devices to containments, if so agreed and specified in the Subsidiary Arrangements; and

(f) To make arrangements with the State for the shipping of samples taken for the Agency's use.

Access for inspections

76. The Agreement should provide that:

(a) For the purposes specified in sub-paragraphs 71(a) and (b) above and until such time as the *strategic points* have been specified in the Subsidiary Arrangements, the Agency's inspectors shall have access to any location where the initial report or any inspections carried out in connection with it indicate that *nuclear material* is present;

(b) For the purposes specified in sub-paragraph 71(c) above the inspectors shall have access to any location of which the Agency has been notified in accordance with sub-paragraphs 92(c) or 95(c) below;

(c) For the purposes specified in paragraph 72 above the Agency's inspectors shall have access only to the *strategic points* specified in the Subsidiary Arrangements and to the records maintained pursuant to paragraphs 51—58 ; and

(d) In the event of the State concluding that any unusual circumstances require extended limitations on access by the Agency, the State and the Agency shall promptly make arrangements with a view to enabling the Agency to discharge its safeguards responsibilities in the light of these limitations. The Director General shall report each such arrangement to the Board.

77. The Agreement should provide that in circumstances which may lead to special inspections for the purposes specified in paragraph 73 above the State and the Agency shall consult forthwith. As a result of such consultations the Agency may make inspections in addition to the routine inspection effort provided for in paragraphs 78—82 below, and may obtain access in agreement with the State to information or locations in addition to the access specified in paragraph 76 above for ad hoc and routine inspections. Any disagreement concerning the need for additional access shall be resolved in accordance with paragraphs 21 and 22; in case action by the State is essential and urgent, paragraph 18 above shall apply.

Frequency and intensity of routine inspections

78. The Agreement should provide that the number, intensity, duration and timing of routine inspections shall be kept to the minimum consistent with

the effective implementation of the safeguards procedures set forth therein, and that the Agency shall make the optimum and most economical use of available inspection resources.

79. The Agreement should provide that in the case of *facilities* and *material balance areas* outside *facilities* with a content or *annual throughput,* whichever is greater, of *nuclear material* not exceeding five *effective kilograms,* routine inspections shall not exceed one per year. For other *facilities* the number, intensity, duration, timing and mode of inspections shall be determined on the basis that in the maximum or limiting case the inspection régime shall be no more intensive than is necessary and sufficient to maintain continuity of knowledge of the flow and inventory of *nuclear material.*

80. The Agreement should provide that the maximum routine inspection effort in respect of *facilities* with a content or *annual throughput* of *nuclear material* exceeding five *effective kilograms* shall be determined as follows:

(a) For reactors and sealed stores, the maximum total of routine inspection per year shall be determined by allowing one sixth of a *man-year of inspection* for each such *facility* in the State;

(b) For other *facilities* involving plutonium or uranium enriched to more than 5%, the maximum total of routine inspection per year shall be determined by allowing for each such *facility* $30 \times \sqrt{E}$ man-days of inspection per year, where E is the inventory or *annual throughput* of *nuclear material,* whichever is greater, expressed in *effective kilograms.* The maximum established for any such *facility* shall not, however, be less than 1.5 *man-years of inspection;* and

(c) For all other *facilities,* the maximum total of routine inspection per year shall be determined by allowing for each such *facility* one third of a *man-year of inspection* plus $0.4 \times E$ man-days of inspection per year, where E is the inventory or *annual throughput* of *nuclear material,* whichever is greater, expressed in *effective kilograms.*

The Agreement should further provide that the Agency and the State may agree to amend the maximum figures specified in this paragraph upon determination by the Board that such amendment is reasonable.

81. Subject to paragraphs 78—80 above the criteria to be used for determining the actual number, intensity, duration, timing and mode of routine inspections of any *facility* shall include:

(a) The form of *nuclear material,* in particular, whether the material is in bulk form or contained in a number of separate items; its chemical composition and, in the case of uranium, whether it is of low or high *enrichment;* and its accessibility;

(b) The effectiveness of the State's accounting and control system, including the extent to which the operators of *facilities* are functionally independent of the State's accounting and control system; the extent to which the measures specified in paragraph 32 above have been implemented by the State; the promptness of reports submitted to the Agency; their consistency with the Agency's independent verification;

and the amount and accuracy of the *material unaccounted for,* as verified by the Agency;

(c) Characteristics of the State's nuclear fuel cycle, in particular, the number and types of *facilities* containing *nuclear material* subject to safeguards, the characteristics of such *facilities* relevant to safeguards, notably the degree of containment; the extent to which the design of such *facilities* facilitates verification of the flow and inventory of *nuclear material;* and the extent to which information from different *material balance areas* can be correlated;

(d) International interdependence, in particular, the extent to which *nuclear material* is received from or sent to other States for use or processing; any verification activity by the Agency in connection therewith; and the extent to which the State's nuclear activities are interrelated with those of other States; and

(e) Technical developments in the field of safeguards, including the use of statistical techniques and random sampling in evaluating the flow of *nuclear material.*

82. The Agreement should provide for consultation between the Agency and the State if the latter considers that the inspection effort is being deployed with undue concentration on particular *facilities.*

Notice of inspections

83. The Agreement should provide that the Agency shall give advance notice to the State before arrival of inspectors at *facilities* or *material balance areas* outside *facilities,* as follows:

(a) For ad hoc inspections pursuant to sub-paragraph 71(c) above, at least 24 hours, for those pursuant to sub-paragraphs 71(a) and (b), as well as the activities provided for in paragraph 48, at least one week ;

(b) For special inspections pursuant to paragraph 73 above, as promptly as possible after the Agency and the State have consulted as provided for in paragraph 77, it being understood that notification of arrival normally will constitute part of the consultations; and

(c) For routine inspections pursuant to paragraph 72 above, at least 24 hours in respect of the *facilities* referred to in sub-paragraph 80(b) and sealed stores containing plutonium or uranium enriched to more than 5%, and one week in all other cases.

Such notice of inspections shall include the names of the inspectors and shall indicate the *facilities* and the *material balance areas* outside *facilities* to be visited and the periods during which they will be visited. If the inspectors are to arrive from outside the State the Agency shall also give advance notice of the place and time of their arrival in the State.

84. However, the Agreement should also provide that, as a supplementary measure, the Agency may carry out without advance notification a portion of the routine inspections pursuant to paragraph 80 above in accordance with

the principle of random sampling. In performing any unannounced inspections, the Agency shall fully take into account any operational programme provided by the State pursuant to paragraph 64(b). Moreover, whenever practicable, and on the basis of the operational programme, it shall advise the State periodically of its general programme of announced and unannounced inspections, specifying the general periods when inspections are foreseen. In carrying out any unannounced inspections, the Agency shall make every effort to minimize any practical difficulties for *facility* operators and the State, bearing in mind the relevant provisions of paragraphs 44 above and 89 below. Similarly the State shall make every effort to facilitate the task of the inspectors.

Designation of inspectors

85. The Agreement should provide that:

(a) The Director General shall inform the State in writing of the name, qualifications, nationality, grade and such other particulars as may be relevant, of each Agency official he proposes for designation as an inspector for the State;

(b) The State shall inform the Director General within 30 days of the receipt of such a proposal whether it accepts the proposal;

(c) The Director General may designate each official who has been accepted by the State as one of the inspectors for the State, and shall inform the State of such designations; and

(d) The Director General, acting in response to a request by the State or on his own initiative, shall immediately inform the State of the withdrawal of the designation of any official as an inspector for the State.

The Agreement should also provide, however, that in respect of inspectors needed for the purposes stated in paragraph 48 above and to carry out ad hoc inspections pursuant to sub-paragraphs 71(a) and (b) the designation procedures shall be completed if possible within 30 days after the entry into force of the Agreement. If such designation appears impossible within this time limit, inspectors for such purposes shall be designated on a temporary basis.

86. The Agreement should provide that the State shall grant or renew as quickly as possible appropriate visas, where required, for each inspector designated for the State.

Conduct and visits of inspectors

87. The Agreement should provide that inspectors, in exercising their functions under paragraphs 48 and 71—75 above, shall carry out their activities in a manner designed to avoid hampering or delaying the construction, commissioning or operation of *facilities,* or affecting their safety. In particular

inspectors shall not operate any *facility* themselves or direct the staff of a *facility* to carry out any operation. If inspectors consider that in pursuance of paragraphs 74 and 75, particular operations in a *facility* should be carried out by the operator, they shall make a request therefor.

88. When inspectors require services available in the State, including the use of equipment, in connection with the performance of inspections, the State shall facilitate the procurement of such services and the use of such equipment by inspectors.

89. The Agreement should provide that the State shall have the right to have inspectors accompanied during their inspections by representatives of the State, provided that inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

STATEMENTS ON THE AGENCY'S VERIFICATION ACTIVITIES

90. The Agreement should provide that the Agency shall inform the State of:

(a) The results of inspections, at intervals to be specified in the Subsidiary Arrangements; and

(b) The conclusions it has drawn from its verification activities in the State, in particular by means of statements in respect of each *material balance area,* which shall be made as soon as possible after a *physical inventory* has been taken and verified by the Agency and a material balance has been struck.

INTERNATIONAL TRANSFERS

General

91. The Agreement should provide that *nuclear material* subject or required to be subject to safeguards thereunder which is transferred internationally shall, for purposes of the Agreement, be regarded as being the responsibility of the State:

(a) In the case of import, from the time that such responsibility ceases to lie with the exporting State, and no later than the time at which the *nuclear material* reaches its destination; and

(b) In the case of export, up to the time at which the recipient State assumes such responsibility, and no later than the time at which the *nuclear material* reaches its destination.

The Agreement should provide that the States concerned shall make suitable arrangements to determine the point at which the transfer of responsibility will take place. No State shall be deemed to have such responsibility for *nuclear material* merely by reason of the fact that the *nuclear material* is in transit on or over its territory or territorial waters, or that it is being transported under its flag or in its aircraft.

Transfers out of the State

92. The Agreement should provide that any intended transfer out of the State of safeguarded *nuclear material* in an amount exceeding one *effective kilogram,* or by successive shipments to the same State within a period of three months each of less than one *effective kilogram* but exceeding in total one *effective kilogram,* shall be notified to the Agency after the conclusion of the contractual arrangements leading to the transfer and normally at least two weeks before the *nuclear material* is to be prepared for shipping. The Agency and the State may agree on different procedures for advance notification. The notification shall specify:

(a) The identification and, if possible, the expected quantity and composition of the *nuclear material* to be transferred, and the *material balance area* from which it will come;

(b) The State for which the *nuclear material* is destined ;

(c) The dates on and locations at which the *nuclear material* is to be prepared for shipping;

(d) The approximate dates of dispatch and arrival of the *nuclear material;* and

(e) At what point of the transfer the recipient State will assume responsibility for the *nuclear material,* and the probable date on which this point will be reached.

93. The Agreement should further provide that the purpose of this notification shall be to enable the Agency if necessary to identify, and if possible verify the quantity and composition of, *nuclear material* subject to safeguards under the Agreement before it is transferred out of the State and, if the Agency so wishes or the State so requests, to affix seals to the *nuclear material* when it has been prepared for shipping. However, the transfer of the *nuclear material* shall not be delayed in any way by any action taken or contemplated by the Agency pursuant to this notification.

94. The Agreement should provide that, if the *nuclear material* will not be subject to Agency safeguards in the recipient State, the exporting State shall make arrangements for the Agency to receive, within three months of the time when the recipient State accepts responsibility for the *nuclear material* from the exporting State, confirmation by the recipient State of the transfer.

Transfers into the State

95. The Agreement should provide that the expected transfer into the State of *nuclear material* required to be subject to safeguards in an amount greater than one *effective kilogram,* or by successive shipments from the same State within a period of three months each of less than one *effective kilogram* but exceeding in total one *effective kilogram,* shall be notified to the Agency as much in advance as possible of the expected arrival of the *nuclear material,* and in any case not later than the date on which the recipient State assumes re-

sponsibility therefor. The Agency and the State may agree on different procedures for advance notification. The notification shall specify:

(a) The identification and, if possible, the expected quantity and composition of the *nuclear material;*

(b) At what point of the transfer responsibility for the *nuclear material* will be assumed by the State for the purposes of the Agreement, and the probable date on which this point will be reached ; and

(c) The expected date of arrival, the location to which the *nuclear material* is to be delivered and the date on which it is intended that the *nuclear material* should be unpacked.

96. The Agreement should provide that the purpose of this notification shall be to enable the Agency if necessary to identify, and if possible verify the quantity and composition of, *nuclear material* subject to safeguards which has been transferred into the State, by means of inspection of the consignment at the time it is unpacked. However, unpacking shall not be delayed by any action taken or contemplated by the Agency pursuant to this notification.

Special reports

97. The Agreement should provide that in the case of international transfers a special report as envisaged in paragraph 68 above shall be made if any unusual incident or circumstances lead the State to believe that there is or may have been loss of *nuclear material,* including the occurrence of significant delay during the transfer.

DEFINITIONS

98. "Adjustment" means an entry into an accounting record or a report showing a *shipper/receiver difference* or *material unaccounted for.*

99. "Annual throughput" means, for the purposes of paragraphs 79 and 80 above, the amount of *nuclear material* transferred annually out of a *facility* working at nominal capacity.

100. "Batch" means a portion of *nuclear material* handled as a unit for accounting purposes at a *key measurement point* and for which the composition and quantity are defined by a single set of specifications or measurements. The *nuclear material* may be in bulk form or contained in a number of separate items.

101. "Batch data" means the total weight of each element of *nuclear material* and, in the case of plutonium and uranium, the isotopic composition when appropriate. The units of account shall be as follows:

(a) Grams of contained plutonium;

(b) Grams of total uranium and grams of contained uranium-235 plus uranium-233 for uranium enriched in these isotopes; and

(c) Kilograms of contained thorium, natural uranium or depleted uranium.

For reporting purposes the weights of individual items in the *batch* shall be added together before rounding to the nearest unit.

102. "Book inventory" of a *material balance area* means the algebraic sum of the most recent *physical inventory* of that *material balance area* and of all *inventory changes* that have occurred since that *physical inventory* was taken.

103. "Correction" means an entry into an accounting record or a report to rectify an identified mistake or to reflect an improved measurement of a quantity previously entered into the record or report. Each correction must identify the entry to which it pertains.

104. "Effective kilogram" means a special unit used in safeguarding *nuclear material*. The quantity in "effective kilograms" is obtained by taking:

(a) For plutonium, its weight in kilograms;

(b) For uranium with an *enrichment* of 0.01 (1%) and above, its weight in kilograms multiplied by the square of its *enrichment;*

(c) For uranium with an *enrichment* below 0.01 (1%) and above 0.005 (0.5%), its weight in kilograms multiplied by 0.0001; and

(d) For depleted uranium with an *enrichment* of 0.005 (0.5%) or below, and for thorium, its weight in kilograms multiplied by 0.00005.

105. "Enrichment" means the ratio of the combined weight of the isotopes uranium-233 and uranium-235 to that of the total uranium in question.

106. "Facility" means:

(a) A reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or

(b) Any location where *nuclear material* in amounts greater than one *effective kilogram* is customarily used.

107. "Inventory change" means an increase or decrease, in terms of *batches,* of *nuclear material* in a *material balance area;* such a change shall involve one of the following:

(a) Increases:

(i) Import;

(ii) Domestic receipt: receipts from other *material balance areas,* receipts from a non-safeguarded (non-peaceful) activity or receipts at the starting point of safeguards;

(iii) Nuclear production: production of special fissionable material in a reactor; and

(iv) De-exemption: reapplication of safeguards on *nuclear material* previously exempted therefrom on account of its use or quantity.

(b) Decreases:

(i) Export;

(ii) Domestic shipment: shipments to other *material balance areas* or shipments for a non-safeguarded (non-peaceful) activity;

(iii) Nuclear loss: loss of *nuclear material* due to its transformation into other element(s) or isotope(s) as a result of nuclear reactions;

(iv) Measured discard: *nuclear material* which has been measured, or estimated on the basis of measurements, and disposed of in such a way that it is not suitable for further nuclear use;

(v) Retained waste: *nuclear material* generated from processing or from an operational accident, which is deemed to be unrecoverable for the time being but which is stored;

(vi) Exemption: exemption of *nuclear material* from safeguards on account of its use or quantity; and

(vii) Other loss: for example, accidental loss (that is, irretrievable and inadvertent loss of *nuclear material* as the result of an operational accident) or theft.

108. "Key measurement point" means a location where *nuclear material* appears in such a form that it may be measured to determine material flow or inventory. "Key measurement points" thus include, but are not limited to, the inputs and outputs (including measured discards) and storages in *material balance areas.*

109. "Man-year of inspection" means, for the purposes of paragraph 80 above, 300 man-days of inspection, a man-day being a day during which a single inspector has access to a *facility* at any time for a total of not more than eight hours.

110. "Material balance area" means an area in or outside of a *facility* such that:

(a) The quantity of *nuclear material* in each transfer into or out of each "material balance area" can be determined; and

(b) The *physical inventory* of *nuclear material* in each "material balance area" can be determined when necessary, in accordance with specified procedures,

in order that the material balance for Agency safeguards purposes can be established.

111. "Material unaccounted for" means the difference between *book inventory* and *physical inventory.*

112. "Nuclear material" means any source or any special fissionable material as defined in Article XX of the Statute. The term source material shall not be interpreted as applying to ore or ore residue. Any determination by the Board under Article XX of the Statute after the entry into force of this Agreement which adds to the materials considered to be source material or special fissionable material shall have effect under this Agreement only upon acceptance by the State.

113. "Physical inventory" means the sum of all the measured or derived estimates of *batch* quantities of *nuclear material* on hand at a given time within a *material balance area,* obtained in accordance with specified procedures.

114. "Shipper/receiver difference" means the difference between the quantity of *nuclear material* in a *batch* as stated by the shipping *material balance area* and as measured at the receiving *material balance area.*

115. "Source data" means those data, recorded during measurement or calibration or used to derive empirical relationships, which identify *nuclear material* and provide *batch data.* "Source data" may include, for example, weight of compounds, conversion factors to determine weight of element, specific gravity,

element concentration, isotopic ratios, relationship between volume and manometer readings and relationship between plutonium produced and power generated.

116. "Strategic point" means a location selected during examination of design information where, under normal conditions and when combined with the information from all "strategic points" taken together, the information necessary and sufficient for the implementation of safeguards measures is obtained and verified; a "strategic point" may include any location where key measurements related to material balance accountancy are made and where containment and surveillance measures are executed.

APPENDIX 5

EXCERPTS FROM THE FIRST REPORT OF THE UNITED NATIONS ATOMIC ENERGY COMMISSION TO THE SECURITY COUNCIL
December 31, 1946.

Part V: *First Report on Safeguards Required To Ensure the Use of Atomic Energy Only for Peaceful Purposes*

Chapter 1: General Introduction

THE MAJOR TASK BEFORE the Atomic Energy Commission is to make specific proposals for the control of atomic energy in order to foster its use only for peaceful purposes and to prevent its use for destructive ends. This task has led us to an analysis of the types of safeguards necessary to afford protection against the hazards of violations and evasions. The report contains the first findings of Committee 2, limited to this aspect of the general problem. These findings have led to the conclusion that a single international control agency must be responsible for the system of safeguards and control. The Committee has not discussed the general characteristics of such an agency or its exact powers in the way, for example, of development, research, or the international planning of atomic energy production. Nor has it considered how the various safeguards would be administered in practice as part of an over-all system.

The report has been prepared in accordance with the following resolution adopted by Committee 2 on October 8, 1946:

> "That Committee 2 proceed to examine and report on the safeguards required at each stage in the production and use of atomic energy for peaceful purposes to prevent the possibilities of misuse indicated in the Report of the Scientific and Technical Committee; that the Committee may hold informal meetings as it may decide, at which scientific Representatives may take part in the discussions."

The program of work adopted by Committee 2, on October 21, 1946, called for the consideration of three distinct kinds of possible misuse: diversion of materials, clandestine operations, and seizures of material or facilities. It was proposed that measures to prevent these possibilities of misuse be considered for each of the following stages in the production and use of atomic energy for peaceful purposes: uranium and thorium mines, concentration plants, refineries, chemical and metallurgical plants, primary reactors and associated chemical separation plants, isotope separation plants, and secondary reactors.

In the course of its deliberations, the Committee heard statements from a number of technical experts who furnished information on all the important stages from the raw material to the production of concentrated nuclear fuel and on other matters. The Committee desires to express its thanks to the Canadian, the United Kingdom, and the United States Delegations which arranged for these experts to attend meetings of the Committee. A list of these experts and the topics on which they tendered information is given in Annex 8.

In the course of the Committee's work, definitions of certain types of safeguards have been formulated and have been used throughout this report. *Control* as used in this report is a general term which includes any or all types of safeguards. The types of safeguards which have been specifically defined are as follows:

1. *Accounting for materials* means the systematic measurement and reporting in prescribed form of quantities of key materials entering and leaving an establishment or installation, in process, and in storage. It includes prescription of the points at which measurements must be taken, the methods of measurements, and the manner in which the data are summarized into accounts. Accounting is normally accompanied by measures of analysis and auditing to ensure conformity between the accounts and the facts. Analysis may be limited to an indirect check of the accounts to test them for consistency. In order to be thoroughly effective, however, accounting for materials must also be extended to direct and simultaneous auditing checks of the accuracy with which individual measurements are incorporated into summary accounts and the validity of the measurements themselves. This necessitates adequate independent observation of the measurements, tests of the accuracy of scales and other measuring instruments, and possibly independent duplicate measurements either on a sampling basis or as a whole. It also implies the right to obtain explanations of discrepancies. When auditing is extended to independent direct checks, it becomes one element in inspection.

2. *Inspection* means close and careful independent scrutiny of operations to detect possible evasions or violations of prescribed methods of operation. In addition to direct auditing measures as

described above, inspection may include observation of points of ingress to and egress from an establishment or installation to ensure that materials and supplies are flowing in the prescribed manner, observation of the activities within the establishment or installation, and measures in the form of aerial or ground survey and otherwise to guard against clandestine activities. To be fully effective, the power of inspection may require that the operations be carried on in a specified manner in order to facilitate the inspection. In this event, inspection verges on supervision.

3. *Supervision* means continuous association and cooperation in day-to-day operations with the management, together with authority to require that the management comply with certain conditions so as to facilitate the execution of measures of control. For example, it may include the right to require that plants be designed and constructed in such a manner as to hinder diversion of materials, the right to require that the processes be conducted in a specified manner, or the right to order cessation of operations to take a complete inventory of materials in process. The more extensive the intervention of the supervisors into such matters, the closer supervision approaches management itself.

4. *Management* means direct power and authority over day-by-day decisions governing the operations themselves as well as advisory responsibility for planning. Managerial control means internal control of a plant by a director or manager. Management by the international control agency means that the management is established by and is responsible to such an agency. Management is normally a prerogative of ownership but need not imply ownership.

5. *Licensing* is a type of safeguard in which the degree of control is determined by the licensing agreement. It means the granting of permission to conduct certain activities under specified conditions. The conditions may include accounting and reporting requirements, rights of inspection or supervision, conformity with approved plant design or processes, etc. Similar results may be obtained through the leasing of establishments or installations from the international control agency or through a management contract, where the conditions are specified in the lease or contract, but leasing is not a prerequisite of licensing.

As explained above, Committee 2 has stressed the specific types of safeguards which should be applied at the several stages in the production and utilization of atomic energy. By this method, the Committee has sought to reach conclusions concerning individual elements of control. While this method is a logical one and enables a study to be made of the separate parts of the problem, the findings thereby arrived at must be viewed in the light of the general objective of securing an effective and enforceable system of control. The detailed findings contained in Chapters 2 to 8, inclusive, are interrelated. The coordination of safeguards is discussed to some extent in Chapter 8, but further measures of coordination must be considered before formulating a comprehensive system of control.

The specific control measures mentioned in the findings are not meant to be definitive but rather to be indicative of the various types of safeguards applicable at each stage. In devising a definite system of control, provision must be made for flexibility in adapting safeguards to a rapidly developing technology. The findings are, moreover, of a technical nature. It has been assumed in the preparation of the report that the staff of the international control agency would be technically competent and loyal to the agency and that it would exercise its functions thoroughly but without encroaching on matters beyond the requirements of the implementation of its mission. It has been assumed, furthermore, that the agency would treat with the necessary discretion information which it acquires.

In considering the types of safeguards to be applied at particular points, the objective has been to provide effectiveness of control with the least interference in normal activities. An ineffective system of control would be worse than none. The interference in a country's normal activities introduced by an effective system of control would be small compared with the disturbances which would result from the defense measures necessary for protection against atomic weapons.

In the preparation of this report there has been no discussion of the type or character of the international control agency in which control authority is to be vested. The over-all powers required by an authority depend upon the functions entrusted to it. Only the functions of providing safeguards against diversion from declared establishments and of discovering clandestine operations have been considered. The question of seizure of atomic energy establishments or materials by a nation intending aggression has only been recognized as a problem for future consideration. The findings, therefore, do not represent a plan for atomic energy control but only some of the elements which should be incorporated in any complete and effective plan.

(A Summary of Findings on Safeguards is included in Part II.)

Chapter 2: Safeguards Necessary To Detect and Prevent the Diversion of Uranium and Thorium From Declared Mines and Mills

Introduction

In the general problem of safeguards, the mines and ore deposits occupy a special position. A complete control at this stage would give a starting point from which it might be possible to keep track of potentially dangerous material through all its later stages. In this connection, the report of the Scientific and Technical Committee states:

> "A special significance must be attached to the devising of adequate safeguards against the diversion of raw materials, since none of the subsequent operations can proceed without uranium, or uranium and thorium."

Findings for Mining and Milling of Uranium

1. In considering the diversion of uranium at the mining and milling stage, one need only be concerned with substantial quantities of material. Occasional petty theft by miners or mill operatives would not be a matter of consequence.

The diversion of many tons of ore would be required to make a few pounds of the finished nuclear fuel.

2. Safeguards to prevent diversion should be determined, to some extent, by the richness of the ore mined. They should be stringent at rich mines and might be less strict for low-grade deposits.

The uranium content of ores varies considerably, ranging from very rich uranium ore to deposits containing small fractions of one percent of uranium. When considering the latter, the following points should be kept in mind:

Ores with a low uranium content are sometimes found in deposits which can be worked by open-pit methods. This means that operations may be scattered over a wide area, and such controls as could be set up at points of egress (e. g. from a mine shaft) would not be possible, unless the whole area were under guard and, if feasible, enclosed. It is probable that in the future substantial amounts of uranium will be derived from very low-grade ores containing other valuable elements. Clearly more rigorous safeguards would become necessary as the uranium becomes concentrated. One must also not overlook dumps of tailings from various mines, mills, and even from certain chemical plants, because these, too poor to have been worked so far for uranium, might contain a very appreciable total amount of this metal.

Knowledge of ore reserves in certain known mines would be a further safeguard against diversion. However, in most mines, sampling methods to prove ore reserves would be inaccurate and difficult to apply as a control measure.

3. The system of accounting, guarding, and inspection of uranium mines and mills could follow the normal patterns ordinarily used in the control of mining and milling operations.

Assuming that egress from the mines or mills is under control by guards checking the contents and destination of shipments, it would appear that substantial or systematic theft of ores or concentrates would probably be detected.

In addition to the physical guarding of its property, management normally has a system of control in its plants to ensure efficient operation. The controls used by the management are designed primarily with a view to detecting technical inefficiencies and ensuring and maintaining maximum recovery. They give a very close check on the flow of material over a long period of time, though they may be inaccurate over short periods.

Adequate facilities for weighing, assay, and analysis are required by the inspectorate. In the simplest case of inspection, the operating controls used by the mine and mill management could be examined and verified with comparative ease by the inspectorate. Under other circumstances, it might be necessary to duplicate controls by having a completely independent and reliable assaying and sampling laboratory. One such laboratory could service a number of mines and mills.

4. An adequate system of inspection could be so organized as not to interfere seriously with normal mining and milling operations.

Inspection of mines and mills is not a new problem but one that has been solved satisfactorily by government authorities inspecting managements to prevent the diversion of the raw materials under government control. It has been proved possible for an independent inspectorate to review the accounting procedures used by the management, check the weighing and assaying equipment, make independent observations, etc., without seriously hampering the management. Experience of this kind has been particularly in the field of precious minerals where very small diversions are important; inspection to detect large-scale diversions should be even less of an interference.

5. The inspectorate must have unrestricted access to all equipment and all phases of the operations and have facilities for independent weighing, assay, and analysis.

It is clear that its complete independence of the local management must be unquestionable.

6. The number of guards and inspectors required for uranium mines and mills would not be great as compared with the operating staff.

The duties of the inspectors would require varying degrees of technical skill and could not be regarded as purely police functions. Persons could be regarded as qualified to serve as the head of a mine or mill inspectorate if, in addition to professional training and experience as engineers, they were given a short course of special instruction.

7. The comparison of weights and assays of the shipped material at the exit from the mill and on arrival at destination would provide a necessary check on possible diversion in transit.

Such checks are normally carried out in mining and refining and would be all the more important in the case of uranium concentrates.

Summary

Adequate safeguards against diversion from declared mines and mills are possible by a system of inspection, including guards, similar to normal managerial operating controls, provided that the inspectorate has unrestricted access to all equipment and operations and has facilities for independent weighing, assay, and analysis.

Findings for Mining and Milling of Thorium

1. The danger inherent in the diversion of thorium is less immediate than in the case of uranium.

Thorium cannot be used by itself for the production of atomic energy; it requires reactors which also use natural uranium or nuclear fuel.

2. The control of thorium would be in some respects more difficult than in the case of uranium.

The most common occurrence of thorium is in monazite sands; and the great extent of some deposits, which may be scattered over hundreds of miles, together with the relatively simple equipment required, makes illicit removals relatively easy. In view of the generally low content of thorium in the sands, however, only a large quantity of material would be significant, and frequent or large-scale illicit operations would probably be readily discovered.

3. Controls for thorium could still be of the same type as those for uranium.

The problems involved in the control of diversion from declared thorium deposits are fundamentally the same as those met in the control of uranium. A system of inspection applied to operations for extracting monazite from sands could follow the same general pattern of material accounting by technical methods together with guards to check shipments and prevent unauthorized removal.

The guarding and patrolling at monazite sand deposits would be relatively more important than in the case of most uranium occurrences.

Summary

Effective control of the raw material and concentrates of thorium is possible through a system of inspection similar to that found adequate for uranium.

Chapter 3: Safeguards Necessary To Detect and Prevent the Diversion of Uranium and Thorium From Declared Refineries and Chemical and Metallurgical Plants

Introduction

In connection with the problem of safeguards at refineries and chemical and metallurgical plants, the report of the Scientific and Technical Committee states:

"Only the application of very close and careful safeguards would provide an adequate assurance against the diversion from those plants of purified chemical compounds of natural uranium or thorium for the surreptitious production of explosive material for atomic weapons."

Findings

1. Total diversion to be dangerous would still be measured in terms of tons, but, because of the greater purity of the materials involved, the quantities concerned would be smaller than in the mining and milling stages.

2. An adequate system of inspection of uranium refineries and chemical and metallurgical plants could follow the normal patterns ordinarily used in the control of similar industrial operations.

As in the case of mines, a system of guards should be provided to control egress from the plant and to check the content and destination of shipments.

Methods of assay and measurement as a basis of accounting have been so developed that at some refineries and chemical and metallurgical plants the uncertainty (technically, the "probable error") on the balance sheet assessed over a period of about a year can be kept by good management to about one percent of the material entering the plant. It is possible in such plants to make a material balance with this accuracy at any time by a clean-up of the material undergoing processing. This naturally interrupts operations, but could reasonably be required at regular intervals and in addition whenever the suspicion of diversion arises. Without a clean-up the uncertainty in the balance over periods of about a month may be several times as great and may vary widely.

Facilities for independent assay and analysis would be part of any inspection system. These might take the form of a central laboratory serving a large number of different plants.

3. An adequate system of inspection could be so organized as not to interfere seriously with normal refining and chemical and metallurgical operations.

As in the case of mines, this kind of inspection is not a new problem but one that has been met and solved in commercial practice.

It is a matter of common practice for the management to shut the plant down at intervals and clean the material out of the various stages of the process. This enables a more accurate accounting to be made of the flow of material through the plant.

An additional safeguard, applicable only to refineries treating the ore concentrates, is a cross-check by comparison of the uranium balance with the balance of radium.

4. The inspectorate must have unrestricted access to all equipment and all phases of the operations and have facilities for independent weighing, assay, and analysis. It must also have the right to require the plant to be shut down for purposes of clean-up and accounting at appropriate times, and also to require efficient operating procedure, assuming to this extent a supervisory character.

5. The number of guards and inspectors required would not be great as compared with the operating staff.

The duties of the inspectors would require varying degrees of technical skill and could not be regarded as purely police functions.

A person could be regarded as qualified to serve as the head of the inspectorate of a refinery, chemical or metallurgical plant if, in addition to having a suitable professional degree and experience, he were given a few months of special instruction.

6. The comparison of weights and analysis of the shipped material when leaving refineries or chemical and metallurgical plants and on arrival at destination would provide a necessary check on possible diversion in transit.

Such checks are normally carried out in dealing with chemicals and would be all the more important in the case of pure uranium metal or compounds.

Summary

Adequate safeguards against diversion from declared refineries and chemical and metallurgical plants are possible by a system of inspection, including guards, similar to normal managerial operating controls, provided that the inspectorate has unrestricted access to all equipment and operations and has facilities for independent weighing, assay, and analysis and provided that it has the right to require the plant to be shut down for purposes of clean-up and accounting at appropriate times and to require efficient operating procedure.

At these stages, there is no fundamental difference between the processes for thorium and for uranium.

Chapter 4: Safeguards Necessary To Detect and Prevent the Diversion of Uranium From Declared Isotope Separation Plants

Introduction

The separation of U–235 from natural uranium and the enrichment of the U–235 content of natural uranium may play an important part in the peaceful use of atomic energy.

Although it is possible that many different processes may be devised for the separation of the isotope U–235 from naturally occurring uranium, existing plants fall into two main groups:

(*a*) Electromagnetic separation plants
(*b*) Plants based on diffusion processes

Isotope separation plants may increase the concentration of U–235 in uranium in varying degrees including that necessary for direct use in an atomic weapon. The necessity for adequate safeguards against diversion presents itself therefore, in these plants, in an acute form.

In this connection, the report of the Scientific and Technical Committee states:

"Production of nuclear fuels is the crucial stage in the operations. . . . Separation plants for the production of uranium enriched in U–235 . . . deliver nuclear fuel which, under proper conditions, may be used directly for the manufacture of atomic weapons. . . . If, therefore, the strictest safeguards are not taken to prevent the material in the installations producing nuclear fuel from being diverted, the danger is extremely serious."

Findings

1. Present electromagnetic and diffusion separation plants have in common the following features which are of importance in determining the necessary safeguards:

(*a*) The complexity and large extent of plants capable of separating significant quantities of U-235

(*b*) The large amount of material at any time in various stages of concentration in the plants

(*c*) The difficulty, under the presently available methods of measurement and with present processes, of any strict accounting of U–235 between the input and output materials

(*d*) The large staff required to operate the plants

(*e*) The absence from the plants of the radiation hazards which provide natural safeguards in certain phases of the operation of reactors.

2. The nature of the plants and the kind of processes to which the material is subjected do not preclude the application of adequate safeguards.

3. The necessary close supervision of the processes and the necessary security measures could only be provided by managerial operation by the international control agency of the whole plant.

Summary

At present, it is not possible to place reliance on the method of obtaining a material balance of uranium isotopes in the case of isotope separation plants. This is one of the important reasons why there must be internal control of such plants by a director or manager and why the management must be established by and responsible to the international control agency. Even if the material balance could be greatly improved, the inherent danger of the operation would still require management by the international control agency.

Chapter 5: Safeguards Necessary To Detect and Prevent the Diversion of Uranium, Thorium, and Plutonium From Declared Nuclear Reactors and Associated Chemical Extraction Plants

Introduction

Reactors may vary greatly in size and design. Present reactors include the large units at Hanford, designed for the production of plutonium from natural uranium, and small reactors for research purposes. Other reactors may be designed primarily for the production of power but may produce nuclear fuel as well.

The chemical plants associated with reactors are for the extraction of the fissionable and radioactive materials produced in the reactors and therefore they introduce the problem of safeguards against the diversion of materials which, even in relatively small quantities, could be used for the immediate manufacture of atomic weapons.

In this connection, the report of the Scientific and Technical Committee states:

"Production of nuclear fuels is the crucial stage in the operations. . . . the reactors and extraction plants for the production of plutonium or U–233 deliver nuclear fuel, which, under proper conditions, may be used directly for the manufacture of atomic weapons. . . . If, therefore, the strictest safeguards are not taken to prevent the material in the installations producing nuclear fuel from being diverted, the danger is extremely serious."

Available information indicates that the utilization of U–233 as nuclear fuel, which can be made from thorium by neutron absorption, though less thoroughly explored than that of plutonium, is theoretically possible. It is believed that safeguards similar to those for uranium and plutonium would be required for thorium and U–233.

Some types of secondary reactors use feed material which is so enriched that it must be very closely safeguarded. Except in this respect, primary and secondary reactors which produce nuclear fuel present similar control problems.

Findings

1. The preparation of natural uranium in an appropriate form for insertion in reactors requires safeguards similar essentially to those for the preceding chemical and metallurgical plants.

2. The international control agency must ensure that no uranium or thorium is surreptitiously placed in or around the reactor.

Uranium or thorium surreptitiously placed in or around the reactor would absorb excess neutrons and thus generate fissionable materials which might escape detection.

3. The injurious radiations from fission products provide a natural assistance to safeguarding against diversion of slugs from the time they are exposed to the neutrons in a working reactor until the radioactive fission products are removed in the chemical extraction plant.

Unless they were transported in containers of conspicuous weight and bulk, slugs which have been in the reactor for any length of time would emit radiations which would be both easy to detect and likely to be fatal to those attempting diversion.

4. The international control agency should supervise the design of the reactors and their associated chemical extraction plants to the extent necessary to preclude features that would make safeguards against diversion difficult. It should also see that construction proceeds according to design.

It is possible otherwise that devices might be put in place during the construction of the reactor or plant through which slugs might be withdrawn with comparative safety.

5. The international control agency should continuously obtain all relevant information on the operation of the reactor by observation and measurement.

This information should include data on the reactor's characteristics and performance, in order that estimates can be made of the amount of plutonium produced and in order that misuse of the reactor can be detected.

6. The diversion of nuclear fuel during the purification process would be extremely grave and might be very difficult to detect.

Diversion becomes easier as concentration is completed and purification proceeds because both the bulk and radioactivity of the material are decreased, making detection more difficult and diminishing the hazard to those engaged in illicit work.

7. As now in operation, the extraction procedure is such that the diversion of purified nuclear fuel might be camouflaged as normal operating losses.

The amount of nuclear fuel in the slugs cannot be accurately determined to begin with, and the losses during chemical treatment introduce further uncertainties. The task of control would be facilitated if, in the future, methods for establishing an accurate balance sheet could be developed.

8. Diversion of purified nuclear fuel is difficult to detect. Assurance against such diversion, therefore, requires that the international control agency itself carry out the functions of management in the case of chemical extraction plants.

9. The international control agency must establish the strictest possible safeguards against diversion of highly enriched or pure nuclear fuel during processing, storage, and shipment.

The nuclear fuel in these conditions is in its ultimate form and can be put to use in an atomic weapon within a few days.

10. From the nature of things, it is not possible at the present moment to decide in a general way the type of control which will offer adequate safeguards against diversion from reactors, but, in many cases, management by the international control agency may be the only adequate safeguard. Secondary power reactors may be fully as dangerous as primary reactors of equivalent capacity, since either may be used to produce nuclear fuel.

11. Satisfactory safeguards in the case of small reactors for research purposes and their associated chemical plants could be provided by a system of licensing and periodic inspection by the international control agency.

Small reactors for research purposes are those not capable of producing nuclear fuel at a rate significant for military purposes. More stringent safeguards might be required where a number of such reactors with a large total content of nuclear fuel or a large potential production exist in any country, or territories under the same national jurisdiction, since a number of these reactors in combination may be fully as dangerous as a large reactor.

Summary

A. At present, it is not possible to place reliance on the method of obtaining a material balance of plutonium in the case of reactors and associated chemical extraction plants. This is one of the important reasons why the chemical extraction plants and, in some cases, the reactors should be subject to internal control by a director or manager and why the management must be established by and be responsible to the international control agency. Even if the material balance could be greatly improved, the inherent danger of the operations would still require management by the international control agency.

B. The safeguards required for the control of reactors will depend on their size and design and especially on their content and possible rate of production of nuclear fuel. The safeguards available to the international control agency should include licensing and inspection, supervision, and management of the operation of reactors. In addition, close supervision of the design and construction of reactors is essential in all cases.

C. Periodic inspection together with licensing is an adequate safeguard in the case of small research reactors and their associated chemical plants, unless their total content of nuclear fuel or potential rate of output in any area is of military significance.

D. Adequate safeguards for chemical extraction plants associated with all except small research reactors are only possible through management by the international control agency.

E. Adequate safeguards during the preparation of high-grade or pure nuclear fuels in a suitable form for insertion in secondary reactors, and, during the storage and shipment of such fuels, are only possible through management by the international control agency.

Chapter 6: Safeguards Necessary To Ensure the Detection of Clandestine Activities

Introduction

Like all problems in atomic energy, the detection of clandestine operations is greatly simplified by the technical facts of the field. Nevertheless, general and political considerations play a larger part in the effectiveness and acceptability of any system for the detection of clandestine operations than in most other parts of the problem. Thus, any form of general inspection by an international control agency raises problems which are beyond the scope of this present enquiry. They will need most careful consideration when the functions, powers, and organization of the agency are defined. It will be here that the conflicts between the requirements of the international control agency on the one hand and considerations of national sovereignty and present practice on the other will have to be resolved. Throughout this chapter of the report, we shall not always state, but shall always assume, that adequate restraints have been provided against the abuse by the international control agency of the wide powers which it must necessarily be given and that it will conduct its activities in conformity with the established regulations.

Measures for the detection of clandestine operations in the realm of atomic energy must be based on information from a variety of sources coordinated and evaluated by a central agency. The control of declared activities will itself provide much useful information. This information, combined with geological data, aerial and ground surveys (see note of Professor Alexandrov in Finding 5), and periodic reports on specified subjects, will aid in directing attention to areas and operations which might be involved in clandestine activities.

It is essential that, within properly defined limits the international control agency be granted freedom of travel, the right of access for inspection, and the right to conduct aerial or ground surveys, if there is to be assurance that clandestine activities on a significant scale will be found. Reasonable and proper use of these rights is necessary to avoid undue interference with activities unrelated to atomic energy, and appropriate restraints are necessary. Even so, it seems inevitable that any system of inspection adequate to ensure the detection of clandestine activities will result in knowledge and inspection of activities unrelated to atomic energy. Particular restraints should therefore be provided against the misuse or disclosure of information secured by the international control agency in the course of its activities.

It appears impracticable and undesirable to attempt the routine inspection of the total industrial operations of a nation in order to detect possible clandestine activities in the realm of atomic energy. Consequently, the problem of detecting clandestine operations at stages subsequent to mining and milling involves, first, the establishment of reasonable grounds for suspecting clandestine operations in a particular plant or area, and, second, the direct inspection of buildings and installations to the extent necessary to resolve reasonable doubts. Stringent safeguards against clandestine mining and milling operations, together with strict control against diversion from authorized activities at all stages, will reduce the necessity for extensive inspection of ordinary manufacturing and processing installations, in which interference would be most irksome.

Findings

1. The right of authorized personnel of the international control agency to direct access and inspection, subject to appropriate restraints, and the right to travel without restraint are essential in the detection of clandestine activities.

Direct inspection is the most reliable means of detecting clandestine activities; hence, the right of inspection wherever suspicion exists constitutes an important safeguard. It would in general be necessary to require that demonstrable grounds for suspicion exist as a justification for inspection and to establish reasonable legal procedures for the regulation of inspection. The procedures must not delay legitimate access by the international control agency. However, there are activities and installations which are so closely linked to atomic energy activities or so readily converted to such activities that their existence *per se* is cause for suspicion and justification for inspection. This includes all mining operations in areas known or likely to contain uranium or thorium in significant amounts. It includes chemical or metallurgical plants processing concentrates which contain even small proportions of uranium or thorium. It includes also certain types of industrial installations, and these should be specified.

2. The character and scale of operations using known processes for the production of significant quantities of nuclear fuels provide useful indications of their existence.

Some of the signposts which point to the existence of these operations are:

(*a*) Mining operations must be substantial.

(*b*) Large or characteristic installations are required in the case of isotope separation plants, primary reactors, and chemical extraction plants.

(*c*) Large amounts of power are required for isotope separation plants.

(*d*) Large quantities of fresh water are required, principally as a cooling medium, in the case of certain reactors. Consequently, such plants are likely to be located on rivers or lakes.

(*e*) In the case of reactors and associated chemical extraction plants, radioactive wastes are produced.

(*f*) Extensive shielding against radiation is required in the case of reactors and associated chemical extraction plants.

The above signposts apply to present types of plants. Rapid technical developments and changes in processes are to be expected, but there is no technological basis for expecting that developments of the next several years will permit the use of installations which are not large enough relative to other industrial installations to attract attention. The importance of this consideration lies in the fact that the size of the installations is the best guarantee that their existence in suspected areas could be detected by aerial surveys. It might be possible to subdivide certain operations in an effort to escape detection, but this would entail an increased number of installations.

3. The international control agency would need periodic reports from States on categories of information directly related to the production and use of atomic energy. Certain ancillary information would also be desirable.

Categories of information on which States should submit reports include:

(*a*) Geological formations in which uranium and thorium might occur.

(*b*) Mining operations large enough to be potential sources of uranium or thorium.

(*c*) Production shipments, location, and use of specialized equipment and supplies such as:

Mass spectrometers,
Diffusion barriers,
Gas centrifuges,
Electromagnetic isotope separation units,
Very pure graphite in large amounts,
Heavy water, and
Beryllium or beryllium compounds in large amounts.

Categories of information which would be desirable include:

(*a*) Large engineering construction.
(*b*) Large producers or consumers of heat or electricity.

4. The international control agency should coordinate the available information and thereby determine what areas and installations require further inspection to resolve reasonable doubt that they contain clandestine activities.

Information of value in the detection of clandestine activities will become available to the international control agency in the course of its control of declared activities.

Information about activities in specific areas could be secured by an appropriate combination of aerial and ground surveys (discussed in Finding 5).

General information related to the production and use of atomic energy could be provided by a system of periodic reports from all national governments (discussed in Finding 3).

Although no one of these types of information alone provides complete assurance that clandestine activities would be detected, the correlation of such information provides a guide to areas and activities requiring direct inspection for clandestine operations.

5. Aerial surveys combined with ground surveys and direct inspection are essential in some circumstances for the detection of clandestine operations.

Aerial surveys are essential in some circumstances to the detection of clandestine operations in areas difficult of access or sparsely populated. The international control agency must therefore be granted the right, under appropriate limitations, to conduct such surveys. In some cases, it will be necessary for the agency to have the permanent right to conduct periodic aerial surveys over areas where uranium and thorium ores are known, or likely, to be found. Air surveys should also be authorized in other cases where grounds for suspicion of clandestine operations are shown in accordance with the procedural requirements referred to in Finding 1.

As a source of information, aerial photography provides a record that is factual, objective, definite, and permanent. Moreover, aerial surveys reduce the time and cost of securing information, especially in examining large areas for unreported mining activities.

(NOTE: During the course of the discussion of the proposals concerning the detection of clandestine activity by means of aerial photography and ground surveys, Professor Alexandrov (U.S.S.R.) stated that the proposals under discussion did, to a great extent, touch more on economic and other spheres not related to atomic energy than on the question of the detection of clandestine activity in the mining and refining of uranium and thorium ores. On this basis, Professor Alexandrov declined to participate in the discussion of those sections of the document dealing with this type of detection.)

Aerial surveys constitute one source of information about geological formations. The completeness of this information varies with the character of the terrain but must ordinarily be supplemented by ground surveys. Aerial surveys have been used successfully to locate areas in which the occurrence of uranium ores appeared probable, and was later confirmed by ground exploration.

Periodic aerial surveys of areas known, or likely, to contain uranium or thorium ores can readily discover the existence of mining operations. Ground inspection would be required to determine the products of the mines.

Aerial surveys are particularly useful for determining the existence or non-existence of industrial installations in an area in which clandestine activities are suspected. The interpretation of aerial photographs of highly industrialized areas is more difficult than in the case of non-industrial areas, but may be a fairly reliable guide in either case. Aerial photographs give considerable information about the general character of the operations conducted in an installation: power requirements; water requirements; and the flow of raw materials and products. However, direct ground inspection is necessary to determine accurately the character of the operations.

New installations, or extensive modifications in existing installations, are readily detectable by comparison of aerial photographs taken at successive intervals.

Camouflage is not very effective against photographic aerial survey but makes it difficult to determine the nature of the installations under observation.

6. Ground surveys are a useful means for the detection of clandestine operations; under certain conditions, the right to conduct such surveys is essential.

The principal objectives of ground surveys would be to locate mines and large industrial buildings, to conduct geologic surveys, to make physical measurements useful in locating clandestine activities (such as seismic measurements to detect blasting), and to sample materials for radioactive elements.

In crowded, built-up areas, ground surveys will ordinarily provide a satisfactory and reasonably convenient means for determining the existence or non-existence of operations which warrant direct inspection. Generally speaking, investigation by ground parties would be likely to pick up less irrelevant information than investigation by aerial surveys. Moreover, certain types of installations cannot be investigated adequately from the air. Examples range from underground structures and installations located in densely wooded areas to ordinary industrial buildings which may be detected with ease, but without reliable indication of the activities involved. Direct inspection may not be required if ground investigation discloses no basis for suspicion.

Ground surveys can be conducted with maximum efficiency if aerial surveys are available as an indication of the areas and installations which warrant attention, as well as the areas which can be ignored without appreciable risk.

The right to conduct ground surveys is essential, but should be subject to appropriate restrictions similar to those required for inspection.

7. Safeguards against the dangers of clandestine mining would be provided by the right of inspection coupled with air and ground surveys based on adequate geological knowledge. Neither air survey nor ground survey alone provides adequate information; both are essential and they must be used in combination.

All available geological knowledge, whether acquired directly or indirectly, is needed by the international control agency to determine the areas to which air and ground surveys should be directed for the detection of possible clandestine mining and milling. Aerial surveys of such areas, which should be provided for in accordance with Finding 5, will ordinarily reveal any unreported operation, or changes in a known installation, but will not usually indicate the character of the operations. Ground surveys may be required in areas not readily evaluated by aerial photography, e.g. heavily wooded areas or caves.

It is assumed that all declared mines producing uranium or thorium would be under controls designed to prevent the diversion of these materials. All other mines would have to be inspected at appropriate intervals to make sure that they did not produce uranium or thorium as by-products, except where the geological formations exclude the possibility of uranium or thorium deposits.

In areas where the occurrence of uranium or thorium is known or probable on the basis of geological information, periodic aerial surveys could provide an adequate check on the existence of unreported mining operations. However, the character of these operations could only be determined by inspection at the mine and sampling of the ore and the products from the mine.

The detection of suspected clandestine mining operations might, on occasion, be facilitated by inspection of transportation facilities and materials being transported to or from areas known, or likely, to contain uranium or thorium deposits. In some cases the means of transportation required for unreported operations located in remote areas would provide an indication of the existence of activity of an unknown character. In cases involving transportation by water or by hydroplane, the usefulness of this method of detecting possible clandestine activities may be quite limited.

8. Clandestine refineries and chemical and metallurgical plants may not differ from conventional chemical processing plants to a degree which would aid in their detection.

Plants for the chemical and metallurgical treatment of uranium and thorium concentrates need not be so large as to attract attention. While the existence of these plants probably could be detected by aerial surveys if they were conducted, there would be little to indicate that they were engaged in clandestine operations. However, these plants alone would not constitute a serious threat, since their product would have to be fed into isotope separation plants or reactors which do have distinguishing characteristics.

9. The detection of clandestine bomb manufacture as such is almost impossible; it is therefore vital that any unauthorized accumulation of essential nuclear fuels be prevented.

Plant installations for the manufacture of bombs are small compared with those required for the production of nuclear fuels, and they have no distinguishing features to facilitate detection. As long as bomb design requires an unusual quality and variety of research personnel, the activities of such personnel might indicate where bombs were being produced clandestinely; however, once the design of atomic weapons had been developed, the need for scientific personnel would be reduced and the value of a knowledge of the activities of key personnel would therefore be slight. Because of the difficulties in detecting clandestine bomb manufacture and because of the extremely short time and small facilities required to produce the bomb if the necessary fissionable material is available, it is essential that stringent safeguards be taken at earlier stages. Accordingly, the prevention of clandestine bomb manufacture must begin with the establishment of safeguards against diversion and clandestine production of raw materials and must be applied at all stages in the production and use of fissionable material.

Summary

A. The international control agency will require broad privileges of movement and inspection, including the rights to conduct surveys by ground and air. These privileges should, however, be very carefully defined to ensure against misuse.

B. Reports and returns on relevant matters will be required from national governments.

C. The international control agency should coordinate all relevant information to determine what areas may be suspected of containing clandestine activities.

D. Isotope separation plants, reactors, and chemical extraction plants, as well as mines, have distinguishing features which would facilitate the detection of clandestine activities at those stages.

E. Detection of clandestine refineries and chemical and metallurgical plants is more difficult than detection of clandestine operations at other stages in the processing of nuclear fuel.

F. The detection of clandestine bomb manufacture as such is almost impossible; it is therefore vital that any unauthorized accumulation of essential nuclear fuels be prevented.

Chapter 7: Safeguards Against the Seizure of Atomic Energy Establishments or Materials

Seizure means the overt removal of declared peaceful activities from the exercise of effective authority by the international control agency. The seriousness of seizure of atomic plants and materials would depend on the stage in the production of nuclear fuels at which seizure occurred. The relative dangers of the material at various stages have been considered and are set forth in the earlier findings. The problem of erecting safeguards against the dangers from seizure is before the Commission, but has not yet been given more than preliminary consideration. However, it is possible at this time to indicate the scope of the problem and some of the considerations involved.

The agreed finding of the Scientific and Technical Committee in this connection, as stated in its report, is:

> "We have been discussing the possibilities of clandestine diversion of materials from the peaceful activities in the domain of atomic energy, but we must not overlook that with certain systems of control one would have to consider the possibility that plants or materials might be seized. This implies a danger, the seriousness of which would be greatest in the case of seizure of stocks of concentrated nuclear fuel, because from that stage weapons could be produced most quickly and in relatively small plants. Next in order of seriousness would be the seizure of plants producing nuclear fuels. A wide geographical dispersal of stocks and plants and the restriction of stocks to minimum operating levels would reduce the risk that a large quantity would be involved in a single seizure. Seizure of mines or of facilities at other early stages would only be of advantage to those desiring to make weapons if they had at their disposal a plant capable of producing nuclear fuel."

Political and general considerations are paramount in the matter of safeguards against seizure. No technical measures are likely to prevent seizure by a nation that has determined upon aggression and such measures as could be administered by an international control agency could hardly give complete satisfaction from the point of view of safety. There may, however, be some measures of a technical nature which could be applied through an international control agency; these measures would assist in forestalling seizure and would tend to minimize the military advantages that an aggressor could expect from seizure.

The nature of the evidence reviewed by the Commission to date suggests that its further deliberations on the subject of seizure should include consideration of the following topics:

1. Seizure as it applies to materials and plants under different types of safeguards
2. The desirability of the geographical dispersal of plants and stocks of materials
3. The possibility of the reduction of inventories of materials in process or in storage

4. The possibility of making the materials for power unsuitable for weapons
5. The desirability of providing for the damaging or destruction of plants before they can be seized

Summary

Problems relating to seizure have been considered thus far only in preliminary terms. The major questions of seizure are political rather than technical. It appears, however, that technical measures could reduce the military advantages and therefore the dangers of seizure.

Chapter 8: Coordination of Safeguards

Introduction

The preceding chapters of this report have discussed the safeguards required at each stage in the production and use of atomic energy to prevent the dangers indicated in the report of the Scientific and Technical Committee. In designing an effective and comprehensive system of control, attention must be given not only to the safeguards required at the several stages but also to the interrelation among those safeguards. Of particular importance in this connection is the scheduling of operations at successive stages in such a way that stocks of dangerous material are kept to a minimum.

The coordination of safeguards raises further important questions as to the nature, organization, and powers of the international control agency responsible for the control of atomic energy. Preliminary investigations have indicated that, when considering the powers of the international control agency, further attention will have to be given to the interrelations among controls at various plants and the degree of control over uranium and thorium through all of the processes. These subjects have not as yet been considered by the Committee.

Findings

1. In addition to material accounting at each individual step in atomic energy processes, the international control agency should provide for material accounting checks between points of shipment and receipt of material as a means of detecting possible diversion in transit.

2. The international control agency should control the storage and shipment of uranium and thorium materials to the degree necessary for security purposes.

3. The international control agency should itself store and itself handle all enriched or pure nuclear fuel in transit. This does not necessarily imply ownership either of the materials or of the transit or storage facilities, questions which have not yet been discussed.

4. Since stocks of concentrated or pure nuclear fuel are acutely dangerous, operations at successive stages in the production of atomic energy should be so scheduled that stocks of materials in transit and in storage are minimized, but without interfering unduly with the development and effectiveness of peaceful activities.

APPENDIX 6

International Atomic Energy Agency

INFORMATION CIRCULAR

INFCIRC/181
27 April 1973
GENERAL Distr.
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THE TEXT OF THE AGREEMENT BETWEEN THE GERMAN DEMOCRATIC REPUBLIC AND THE AGENCY FOR THE APPLICATION OF SAFEGUARDS IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS

1. The text [1] of the Agreement between the German Democratic Republic and the Agency for the application of safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons [2] is reproduced in this document for the information of all Members.

2. The Agreement entered into force on 7 March 1972, the date on which the Agency received the notification provided for in Article 24.

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[1] The footnote to the text has been added to the present information circular.

[2] Reproduced in document INFCIRC/140.

AGREEMENT BETWEEN THE GOVERNMENT OF THE GERMAN DEMOCRATIC REPUBLIC AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR THE APPLICATION OF SAFEGUARDS IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS

WHEREAS the German Democratic Republic (hereinafter referred to as "the G. D. R.") is a party to the Treaty on the Non-Proliferation of Nuclear Weapons (hereinafter referred to as "the Treaty") opened for signature at London, Moscow and Washington on 1 July 1968 and which entered into force on 5 March 1970;

WHEREAS it is the inalienable right of the G. D. R. to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with the relevant provisions of the Treaty;

WHEREAS the G. D. R. has undertaken to conclude an agreement with the International Atomic Energy Agency (hereinafter referred to as "the Agency") for the application of safeguards to the G. D. R.'s peaceful nuclear activities pursuant to paragraph 1 of Article III of the Treaty;

WHEREAS the Agency is authorized, pursuant to Article III of its Statute, to conclude such agreements;

NOW THEREFORE the Government of the G. D. R. and the Agency have agreed as follows:

PART I

BASIC UNDERTAKING

Article 1

The Government of the G. D. R. undertakes, pursuant to paragraph 1 of Article III of the Treaty, to accept safeguards, in accordance with the terms of this Agreement, on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

APPLICATION OF SAFEGUARDS

Article 2

The Agency shall have the right and the obligation to ensure that safeguards will be applied, in accordance with the terms of this Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the G. D. R., under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

CO-OPERATION BETWEEN THE GOVERNMENT OF THE G.D.R. AND THE AGENCY

Article 3

The Government of the G.D.R. and the Agency shall co-operate to facilitate the implementation of the safeguards provided for in this Agreement.

IMPLEMENTATION OF SAFEGUARDS

Article 4

The safeguards provided for in this Agreement shall be implemented in a manner designed:

(a) To avoid hampering the economic and technological development of the G.D.R. or international co-operation in the field of peaceful nuclear activities, including international exchange of nuclear material;

(b) To avoid undue interference in the G.D.R.'s peaceful nuclear activities, and in particular in the operation of facilities; and

(c) To be consistent with prudent management practices required for the economic and safe conduct of nuclear activities.

Article 5

(a) The Agency shall take every precaution to protect commercial and industrial secrets and other confidential information coming to its knowledge in the implementation of this Agreement.

(b) (i) The Agency shall not publish or communicate to any State, organization or person any information obtained by it in connection with the implementation of this Agreement, except that specific information relating to the implementation thereof may be given to the Board of Governors of the Agency (hereinafter referred to as "the Board") and to such Agency staff members as require such knowledge by reason of their official duties in connection with safeguards, but only to the extent necessary for the Agency to fulfil its responsibilities in implementing this Agreement.

(ii) Summarized information on nuclear material subject to safeguards under this Agreement may be published upon decision of the Board if the Government of the G.D.R. agrees thereto.

Article 6

(a) The Agency shall, in implementing safeguards pursuant to this Agreement, take full account of technological developments in the field of safeguards, and shall make every effort to ensure optimum cost-effectiveness and the application of the principle of safeguarding effectively the flow of nuclear material subject to safeguards under this Agreement by use of instruments and other techniques at certain strategic points to the extent that present or future technology permits.

(b) In order to ensure optimum cost-effectiveness, use shall be made, for example, of such means as:

(i) Containment as a means of defining material balance areas for accounting purposes;

(ii) Statistical techniques and random sampling in evaluating the flow of nuclear material; and

(iii) Concentration of verification procedures on those stages in the nuclear fuel cycle involving the production, processing, use or storage of nuclear material from which nuclear weapons or other nuclear explosive devices could readily be made, and minimization of verification procedures in respect of other nuclear material, on condition that this does not hamper the Agency in applying safeguards under this Agreement.

THE G. D. R.'S SYSTEM OF MATERIALS CONTROL

Article 7

(a) The Government of the G. D. R. shall establish and maintain a system of accounting for and control of all nuclear material subject to safeguards under this Agreement.

(b) The Agency shall apply safeguards in such a manner as to enable it to verify, in ascertaining that there has been no diversion of nuclear material from peaceful uses to nuclear weapons or other nuclear explosive devices, findings of the G. D. R.'s system. The Agency's verification shall include, inter alia, independent measurements and observations conducted by the Agency in accordance with the procedures specified in Part II of this Agreement. The Agency, in its verification, shall take due account of the technical effectiveness of the G. D. R.'s system.

PROVISION OF INFORMATION TO THE AGENCY

Article 8

(a) In order to ensure the effective implementation of safeguards under this Agreement, the Government of the G. D. R. shall, in accordance with the provisions set out in Part II of this Agreement, provide the Agency with information concerning nuclear material subject to safeguards under this Agreement and the features of facilities relevant to safeguarding such material.

(b) (i) The Agency shall require only the minimum amount of information and data consistent with carrying out its responsibilities under this Agreement.

(ii) Information pertaining to facilities shall be the minimum necessary for safeguarding nuclear material subject to safeguards under this Agreement.

(c) If the Government of the G. D. R. so requests, the Agency shall be prepared to examine on premises of the G. D. R. design information which the Government of the G. D. R. regards as being of particular sensitivity. Such information need not be physically transmitted to the Agency provided that it remains readily available for further examination by the Agency on premises of the G. D. R.

AGENCY INSPECTORS

Article 9

(a) (i) The Agency shall secure the consent of the Government of the G. D. R. to the designation of Agency inspectors to the G. D. R.

(ii) If the Government of the G. D. R., either upon proposal of a designation or at any other time after a designation has been made, objects to the designation, the Agency shall propose to the Government of the G. D. R. an alternative designation or designations.

(iii) If, as a result of the repeated refusal of the Government of the G. D. R. to accept the designation of Agency inspectors, inspections to be conducted under this Agreement would be impeded, such refusal shall be considered by the Board, upon referral by the Director General of the Agency (hereinafter referred to as "the Director General"), with a view to its taking appropriate action.

(b) The Government of the G. D. R. shall take the necessary steps to ensure that Agency inspectors can effectively discharge their functions under this Agreement.

(c) The visits and activities of Agency inspectors shall be so arranged as:

(i) To reduce to a minimum the possible inconvenience and disturbance to the G. D. R. and to the peaceful nuclear activities inspected; and

(ii) To ensure protection of industrial secrets or any other confidential information coming to the inspectors' knowledge.

PRIVILEGES AND IMMUNITIES

Article 10

The Government of the G. D. R. shall accord to the Agency (including its property, funds and assets) and to its inspectors and other officials, performing functions under this Agreement, the same privileges and immunities as those set forth in the relevant provisions of the Agreement on the Privileges and Immunities of the International Atomic Energy Agency [3].

TERMINATION OF SAFEGUARDS

Consumption or dilution of nuclear material

Article 11

Safeguards shall terminate on nuclear material upon determination by the Agency that the material has been consumed, or has been diluted in such a way that it is no longer usable for any nuclear activity relevant from the point of view of safeguards, or has become practically irrecoverable.

Transfer of nuclear material out of the G. D. R.

Article 12

The Government of the G. D. R. shall give the Agency advance notification of intended transfers of nuclear material subject to safeguards under this Agreement out of the G. D. R., in accordance with the provisions set out in Part II of this Agreement. The Agency shall terminate safeguards on nuclear material under this Agreement when the recipient State has assumed responsibility therefor, as provided for in Part II of this Agreement. The Agency shall maintain records indicating each transfer and, where applicable, the re-application of safeguards to the transferred nuclear material.

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[3] INFCIRC/9/Rev. 2.

Provisions relating to nuclear material to be used in non-nuclear activities

Article 13

Where nuclear material subject to safeguards under this Agreement is to be used in non-nuclear activities, such as the production of alloys or ceramics, the Government of the G.D.R. shall agree with the Agency, before the material is so used, on the circumstances under which the safeguards on such material may be terminated.

NON-APPLICATION OF SAFEGUARDS TO NUCLEAR MATERIAL TO BE USED IN NON-PEACEFUL ACTIVITIES

Article 14

If the Government of the G.D.R. intends to exercise its discretion to use nuclear material which is required to be safeguarded under this Agreement in a nuclear activity which does not require the application of safeguards under this Agreement, the following procedures shall apply:

(a) The Government of the G.D.R. shall inform the Agency of the activity, making it clear:

   (i) That the use of the nuclear material in a non-proscribed military activity will not be in conflict with an undertaking the G.D.R. may have given and in respect of which Agency safeguards apply, that the material will be used only in a peaceful nuclear activity; and

   (ii) That during the period of non-application of safeguards the nuclear material will not be used for the production of nuclear weapons or other nuclear explosive devices;

(b) The Government of the G.D.R. and the Agency shall make an arrangement so that, only while the nuclear material is in such an activity, the safeguards provided for in this Agreement will not be applied. The arrangement shall identify, to the extent possible, the period or circumstances during which safeguards will not be applied. In any event, the safeguards provided for in this Agreement shall apply again as soon as the nuclear material is reintroduced into a peaceful nuclear activity. The Agency shall be kept informed of the total quantity and composition of such unsafeguarded material in the G.D.R. and of any export of such material; and

(c) Each arrangement shall be made in agreement with the Agency. Such agreement shall be given as promptly as possible and shall relate only to such matters as, inter alia, temporal and procedural provisions and reporting arrangements, but shall not involve any approval or classified knowledge of the military activity or relate to the use of the nuclear material therein.

FINANCE

Article 15

The Government of the G.D.R. shall fully reimburse to the Agency the safeguards expenses which the Agency incurs under this Agreement. However, if the G.D.R. or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the Agency, the Agency shall reimburse such expenses provided that it has agreed in advance to do so. In any case the Agency shall bear the cost of any additional measuring or sampling which inspectors may request.

THIRD PARTY LIABILITY FOR NUCLEAR DAMAGE

Article 16

The Government of the G. D. R. shall ensure that any protection against third party liability in respect of nuclear damage, including any insurance or other financial security, which may be available under its laws or regulations shall apply to the Agency and its officials for the purpose of the implementation of this Agreement, in the same way as that protection applies to nationals of the G. D. R.

INTERNATIONAL RESPONSIBILITY

Article 17

Any claim by the G. D. R. against the Agency or by the Agency against the G. D. R. in respect of any damage resulting from the implementation of safeguards under this Agreement, other than damage arising out of a nuclear incident, shall be settled in accordance with international law.

MEASURES IN RELATION TO VERIFICATION OF NON-DIVERSION

Article 18

If the Board, upon report of the Director General, decides that an action by the Government of the G. D. R. is essential and urgent in order to ensure verification that nuclear material subject to safeguards under this Agreement is not diverted to nuclear weapons or other nuclear explosive devices, the Board may call upon the Government of the G. D. R. to take the required action without delay, irrespective of whether procedures have been invoked pursuant to Article 22 of this Agreement for the settlement of a dispute.

Article 19

If the Board, upon examination of relevant information reported to it by the Director General, finds that the Agency is not able to verify that there has been no diversion of nuclear material required to be safeguarded under this Agreement, to nuclear weapons or other nuclear explosive devices, it may make the reports provided for in paragraph C of Article XII of the Statute of the Agency (hereinafter referred to as "the Statute") and may also take, where applicable, the other measures provided for in that paragraph. In taking such action the Board shall take account of the degree of assurance provided by the safeguards measures that have been applied and shall afford the Government of the G. D. R. every reasonable opportunity to furnish the Board with any necessary reassurance.

INTERPRETATION AND APPLICATION OF THE AGREEMENT AND SETTLEMENT OF DISPUTES

Article 20

The Government of the G. D. R. and the Agency shall, at the request of either, consult about any question arising out of the interpretation or application of this Agreement.

Article 21

The Government of the G. D. R. shall have the right to request that any question arising out of the interpretation or application of this Agreement be considered by the Board. The Board shall invite the Government of the G. D. R. to participate in the discussion of any such question by the Board.

Article 22

Any dispute arising out of the interpretation or application of this Agreement, except a dispute with regard to a finding by the Board under Article 19 or an action taken by the Board pursuant to such a finding, which is not settled by negotiation or another procedure agreed to by the Government of the G. D. R. and the Agency shall, at the request of either, be submitted to an arbitral tribunal composed as follows: the Government of the G. D. R. and the Agency shall each designate one arbitrator, and the two arbitrators so designated shall elect a third, who shall be the Chairman. If, within thirty days of the request for arbitration, either the Government of the G. D. R. or the Agency has not designated an arbitrator, either the Government of the G. D. R. or the Agency may request the President of the International Court of Justice to appoint an arbitrator. The same procedure shall apply if, within thirty days of the designation or appointment of the second arbitrator, the third arbitrator has not been elected. A majority of the members of the arbitral tribunal shall constitute a quorum, and all decisions shall require the concurrence of two arbitrators. The arbitral procedure shall be fixed by the tribunal. The decisions of the tribunal shall be binding on the Government of the G. D. R. and the Agency.

AMENDMENT OF THE AGREEMENT

Article 23

(a) The Government of the G. D. R. and the Agency shall, at the request of either, consult each other on amendment to this Agreement.

(b) All amendments shall require the agreement of the Government of the G. D. R. and the Agency.

(c) Amendments to this Agreement shall enter into force in the same conditions as entry into force of the Agreement itself or, if mutually so desired, in accordance with a simplified procedure.

ENTRY INTO FORCE, INFORMATION AND DURATION

Article 24

This Agreement shall enter into force on the date upon which the Agency receives from the Government of the G. D. R. written notification that the G. D. R.'s statutory and constitutional requirements for entry into force have been met.

Article 25

The Director General shall promptly inform all Member States of the Agency of the entry into force of this Agreement as well as of any amendment thereto.

Article 26

This Agreement shall remain in force as long as the G. D. R. is party to the Treaty.

PART II

INTRODUCTION

Article 27

The purpose of this part of the Agreement is to specify the procedures to be applied in the implementation of the safeguards provisions of Part I.

OBJECTIVE OF SAFEGUARDS

Article 28

The objective of the safeguards procedures set forth in this part of the Agreement is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.

Article 29

For the purpose of achieving the objective set forth in Article 28, material accountancy shall be used as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures.

Article 30

The technical conclusion of the Agency's verification activities shall be a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, and giving the limits of accuracy of the amounts stated.

THE G.D.R.'s SYSTEM OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIAL

Article 31

Pursuant to Article 7 the Agency, in carrying out its verification activities, shall make full use of the G.D.R.'s system of accounting for and control of all nuclear material subject to safeguards under this Agreement and shall avoid unnecessary duplication of the G.D.R.'s accounting and control activities.

Article 32

The G.D.R.'s system of accounting for and control of all nuclear material subject to safeguards under this Agreement shall be based on a structure of material balance areas, and shall make provision, as appropriate and specified in the Subsidiary Arrangements, for the establishment of such measures as:

(a) A measurement system for the determination of the quantities of nuclear material received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory;

(b) The evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty;

(c) Procedures for identifying, reviewing and evaluating differences in shipper/receiver measurements;

(d) Procedures for taking a physical inventory;

(e) Procedures for the evaluation of accumulations of unmeasured inventory and unmeasured losses;

(f) A system of records and reports showing, for each material balance area, the inventory of nuclear material and the changes in that inventory including receipts into and transfers out of the material balance area;

(g) Provisions to ensure that the accounting procedures and arrangements are being operated correctly; and

(h) Procedures for the provision of reports to the Agency in accordance with Articles 59-69.

STARTING POINT OF SAFEGUARDS

Article 33

Safeguards under this Agreement shall not apply to material in mining or ore processing activities.

Article 34

(a) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in paragraph (c) is directly or indirectly exported to a non-nuclear-weapon State, the Government of the G. D. R. shall inform the Agency of its quantity, composition and destination, unless the material is exported for specifically non-nuclear purposes;

(b) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in paragraph (c) is imported, the Government of the G. D. R. shall inform the Agency of its quantity and composition, unless the material is imported for specifically non-nuclear purposes; and

(c) When any nuclear material of a composition and purity suitable for fuel fabrication or for isotopic enrichment leaves the plant or the process stage in which it has been produced, or when such nuclear material, or any other nuclear material produced at a later stage in the nuclear fuel cycle, is imported into the G. D. R., the nuclear material shall become subject to the other safeguards procedures specified in this Agreement.

TERMINATION OF SAFEGUARDS

Article 35

(a) Safeguards shall terminate on nuclear material subject to safeguards under this Agreement, under the conditions set forth in Article 11. Where the conditions of that Article are not met, but the Government of the G. D. R. considers that the recovery of safeguarded nuclear material from residues is not for the time being practicable or desirable, the Government of the G. D. R. and the Agency shall consult on the appropriate safeguards measures to be applied.

(b) Safeguards shall terminate on nuclear material subject to safeguards under this Agreement, under the conditions set forth in Article 13, provided that the Government of the G. D. R. and the Agency agree that such nuclear material is practicably irrecoverable.

EXEMPTIONS FROM SAFEGUARDS

Article 36

At the request of the Government of the G.D.R., the Agency shall exempt nuclear material from safeguards, as follows:

(a) Special fissionable material, when it is used in gram quantities or less as a sensing component in instruments;

(b) Nuclear material, when it is used in non-nuclear activities in accordance with Article 13, if such nuclear material is recoverable; and

(c) Plutonium with an isotopic concentration of plutonium-238 exceeding 80%.

Article 37

At the request of the Government of the G.D.R., the Agency shall exempt from safeguards nuclear material that would otherwise be subject to safeguards, provided that the total quantity of nuclear material which has been exempted in the G.D.R. in accordance with this Article may not at any time exceed:

(a) One kilogram in total of special fissionable material, which may consist of one or more of the following:

  (i) Plutonium;

  (ii) Uranium with an enrichment of 0.2 (20%) and above, taken account of by multiplying its weight by its enrichment; and

  (iii) Uranium with an enrichment below 0.2 (20%) and above that of natural uranium, taken account of by multiplying its weight by five times the square of its enrichment;

(b) Ten metric tons in total of natural uranium and depleted uranium with an enrichment above 0.005 (0.5%);

(c) Twenty metric tons of depleted uranium with an enrichment of 0.005 (0.5%) or below; and

(d) Twenty metric tons of thorium;

or such greater amounts as may be specified by the Board for uniform application.

Article 38

If exempted nuclear material is to be processed or stored together with nuclear material subject to safeguards under this Agreement, provision shall be made for the re-application of safeguards thereto.

SUBSIDIARY ARRANGEMENTS

Article 39

The Government of the G.D.R. and the Agency shall make Subsidiary Arrangements which shall specify in detail, to the extent necessary to permit the Agency to fulfil its responsibilities under this Agreement in an effective and efficient manner, how the procedures laid down in this Agreement are to be applied. The Subsidiary Arrangements may be extended or changed by agreement between the Government of the G.D.R. and the Agency without amendment of this Agreement.

Article 40

The Subsidiary Arrangements shall enter into force at the same time as, or as soon as possible after, the entry into force of this Agreement. The Government of the G.D.R. and the Agency shall make every effort to achieve their entry into force within ninety days of the entry into force of this Agreement; an extension of that period shall require agreement between the Government of the G.D.R. and the Agency. The Government of the G.D.R. shall provide the Agency promptly with the information required for completing the Subsidiary Arrangements. Upon the entry into force of this Agreement, the Agency shall have the right to apply the procedures laid down therein in respect of the nuclear material listed in the inventory provided for in Article 41, even if the Subsidiary Arrangements have not yet entered into force.

INVENTORY

Article 41

On the basis of the initial report referred to in Article 62, the Agency shall establish a unified inventory of all nuclear material in the G.D.R. subject to safeguards under this Agreement, irrespective of its origin, and shall maintain this inventory on the basis of subsequent reports and of the results of its verification activities. Copies of the inventory shall be made available to the Government of the G.D.R. at intervals to be agreed.

DESIGN INFORMATION

General provisions

Article 42

Pursuant to Article 8, design information in respect of existing facilities shall be provided to the Agency during the discussion of the Subsidiary Arrangements. The time limits for the provision of design information in respect of the new facilities shall be specified in the Subsidiary Arrangements and such information shall be provided as early as possible before nuclear material is introduced into a new facility.

Article 43

The design information to be provided to the Agency shall include, in respect of each facility, when applicable:

(a) The identification of the facility, stating its general character, purpose, nominal capacity and geographic location, and the name and address to be used for routine business purposes;

(b) A description of the general arrangement of the facility with reference, to the extent feasible, to the form, location and flow of nuclear material and to the general layout of important items of equipment which use, produce or process nuclear material;

(c) A description of features of the facility relating to material accountancy, containment and surveillance; and

(d) A description of the existing and proposed procedures at the facility for nuclear material accountancy and control, with special reference to material balance areas established by the operator, measurements of flow and procedures for physical inventory taking.

Article 44

Other information relevant to the application of safeguards shall also be provided to the Agency in respect of each facility, in particular on organizational responsibility for material accountancy and control. The Government of the G.D.R. shall provide the Agency with supplementary information on the health and safety procedures which the Agency shall observe and with which the inspectors shall comply at the facility.

Article 45

The Agency shall be provided with design information in respect of a modification relevant for safeguards purposes, for examination, and shall be informed of any change in the information provided to it under Article 44, sufficiently in advance for the safeguards procedures to be adjusted when necessary.

Purposes of examination of design information

Article 46

The design information provided to the Agency shall be used for the following purposes:

(a) To identify the features of facilities and nuclear material relevant to the application of safeguards to nuclear material in sufficient detail to facilitate verification;

(b) To determine material balance areas to be used for Agency accounting purposes and to select those strategic points which are key measurement points and which will be used to determine flow and inventory of nuclear material; in determining such material balance areas the Agency shall, inter alia, use the following criteria:

(i) The size of the material balance area shall be related to the accuracy with which the material balance can be established;

(ii) In determining the material balance area advantage shall be taken of any opportunity to use containment and surveillance to help ensure the completeness of flow measurements and thereby to simplify the application of safeguards and to concentrate measurement efforts at key measurement points;

(iii) A number of material balance areas in use at a facility or at distinct sites may be combined in one material balance area to be used for Agency accounting purposes when the Agency determines that this is consistent with its verification requirements; and

(iv) A special material balance area may be established at the request of the Government of the G.D.R. around a process step involving commercially sensitive information;

(c) To establish the nominal timing and procedures for taking of physical inventory of nuclear material for Agency accounting purposes;

(d) To establish the records and reports requirements and records evaluation procedures;

(e) To establish requirements and procedures for verification of the quantity and location of nuclear material; and

(f) To select appropriate combinations of containment and surveillance methods and techniques and the strategic points at which they are to be applied.

The results of the examination of the design information shall be included in the Subsidiary Arrangements.

Re-examination of design information

Article 47

Design information shall be re-examined in the light of changes in operating conditions, of developments in safeguards technology or of experience in the application of verification procedures, with a view to modifying the action the Agency has taken pursuant to Article 46.

Verification of design information

Article 48

The Agency, in co-operation with the Government of the G. D. R., may send inspectors to facilities to verify the design information provided to the Agency pursuant to Articles 42-45, for the purposes stated in Article 46.

INFORMATION IN RESPECT OF NUCLEAR MATERIAL OUTSIDE FACILITIES

Article 49

The Agency shall be provided with the following information when nuclear material is to be customarily used outside facilities, as applicable:

(a) A general description of the use of the nuclear material, its geographic location, and the user's name and address for routine business purposes; and

(b) A general description of the existing and proposed procedures for nuclear material accountancy and control, including organizational responsibility for material accountancy and control.

The Agency shall be informed, on a timely basis, of any change in the information provided to it under this Article.

Article 50

The information provided to the Agency pursuant to Article 49 may be used, to the extent relevant, for the purposes set out in Article 46(b)-(f).

RECORDS SYSTEM

General provisions

Article 51

In establishing the G. D. R.'s system of materials control as referred to in Article 7, the Government of the G. D. R. shall arrange that records are kept in respect of each material balance area. The records to be kept shall be described in the Subsidiary Arrangements.

Article 52

The Government of the G. D. R. shall make arrangements to facilitate the examination of records by inspectors, particularly if the records are not kept in English, French, Russian or Spanish.

Article 53

Records shall be retained for at least five years.

Article 54

Records shall consist, as appropriate, of:

(a) Accounting records of all nuclear material subject to safeguards under this Agreement; and

(b) Operating records for facilities containing such nuclear material.

Article 55

The system of measurements on which the records used for the preparation of reports are based shall either conform to the latest international standards or be equivalent in quality to such standards.

Accounting records

Article 56

The accounting records shall set forth the following in respect of each material balance area:

(a) All inventory changes, so as to permit a determination of the book inventory at any time;

(b) All measurement results that are used for determination of the physical inventory; and

(c) All adjustments and corrections that have been made in respect of inventory changes, book inventories and physical inventories.

Article 57

For all inventory changes and physical inventories the records shall show, in respect of each batch of nuclear material: material identification, batch data and source data. The records shall account for uranium, thorium and plutonium separately in each batch of nuclear material. For each inventory change, the date of the inventory change and, when appropriate, the originating material balance area and the receiving material balance area or the recipient, shall be indicated.

Operating records

Article 58

The operating records shall set forth, as appropriate, in respect of each material balance area:

(a) Those operating data which are used to establish changes in the quantities and composition of nuclear material;

(b) The data obtained from the calibration of tanks and instruments and from sampling and analyses, the procedures to control the quality of measurements and the derived estimates of random and systematic error;

(c) A description of the sequence of the actions taken in preparing for, and in taking, a physical inventory, in order to ensure that it is correct and complete; and

(d) A description of the actions taken in order to ascertain the cause and magnitude of any accidental or unmeasured loss that might occur.

REPORTS SYSTEM

General provisions

Article 59

The Government of the G.D.R. shall provide the Agency with reports as detailed in Articles 60-69 in respect of nuclear material subject to safeguards under this Agreement.

Article 60

Reports shall be made in English, French, Russian or Spanish, except as otherwise specified in the Subsidiary Arrangements.

Article 61

Reports shall be based on the records kept in accordance with Articles 51-58 and shall consist, as appropriate, of accounting reports and special reports.

Accounting reports

Article 62

The Agency shall be provided with an initial report on all nuclear material subject to safeguards under this Agreement. The initial report shall be dispatched by the Government of the G.D.R. to the Agency within thirty days of the last day of the calendar month in which this Agreement enters into force, and shall reflect the situation as of the last day of that month.

Article 63

The Government of the G.D.R. shall provide the Agency with the following accounting reports for each material balance area:

(a) Inventory change reports showing all changes in the inventory of nuclear material. The reports shall be dispatched as soon as possible and in any event within thirty days after the end of the month in which the inventory changes occurred or were established; and

(b) Material balance reports showing the material balance based on a physical inventory of nuclear material actually present in the material balance area. The reports shall be dispatched as soon as possible and in any event within thirty days after the physical inventory has been taken.

The reports shall be based on data available as of the date of reporting and may be corrected at a later date, as required.

Article 64

Inventory change reports shall specify identification and batch data for each batch of nuclear material, the date of the inventory change and, as appropriate, the originating material balance area and the receiving material balance area or the recipient. These reports shall be accompanied by concise notes:

(a) Explaining the inventory changes, on the basis of the operating data contained in the operating records provided for under Article 58(a); and

(b) Describing, as specified in the Subsidiary Arrangements, the anticipated operational programme, particularly the taking of a physical inventory.

Article 65

The Government of the G.D.R. shall report each inventory change, adjustment and correction, either periodically in a consolidated list or individually. Inventory changes shall be reported in terms of batches. As specified in the Subsidiary Arrangements, small changes in inventory of nuclear material, such as transfers of analytical samples, may be combined in one batch and reported as one inventory change.

Article 66

The Agency shall provide the Government of the G.D.R. with semi-annual statements of book inventory of nuclear material subject to safeguards under this Agreement, for each material balance area, as based on the inventory change reports for the period covered by each such statement.

Article 67

Material balance reports shall include the following entries, unless otherwise agreed by the Government of the G.D.R. and the Agency:

(a) Beginning physical inventory;

(b) Inventory changes (first increases, then decreases);

(c) Ending book inventory;

(d) Shipper/receiver differences;

(e) Adjusted ending book inventory;

(f) Ending physical inventory; and

(g) Material unaccounted for.

A statement of the physical inventory, listing all batches separately and specifying material identification and batch data for each batch, shall be attached to each material balance report.

Special reports

Article 68

The Government of the G.D.R. shall make special reports without delay:

(a) If any unusual incident or circumstances lead the Government of the G.D.R. to believe that there is or may have been loss of nuclear material that exceeds the limits specified for this purpose in the Subsidiary Arrangements; or

(b) If the containment has unexpectedly changed from that specified in the Subsidiary Arrangements to the extent that unauthorized removal of nuclear material has become possible.

Amplification and clarification of reports

Article 69

If the Agency so requests, the Government of the G. D. R. shall provide it with amplifications or clarifications of any report, in so far as relevant for the purpose of safeguards.

INSPECTIONS

General provisions

Article 70

The Agency shall have the right to make inspections as provided for in Articles 71-82.

Purposes of inspections

Article 71

The Agency may make ad hoc inspections in order to:

(a) Verify the information contained in the initial report on the nuclear material subject to safeguards under this Agreement;

(b) Identify and verify changes in the situation which have occurred since the date of the initial report; and

(c) Identify, and if possible verify the quantity and composition of, nuclear material in accordance with Articles 93 and 96, before its transfer out of or upon its transfer into the G. D. R.

Article 72

The Agency may make routine inspections in order to:

(a) Verify that reports are consistent with records;

(b) Verify the location, identity, quantity and composition of all nuclear material subject to safeguards under this Agreement; and

(c) Verify information on the possible causes of material unaccounted for, shipper/ receiver differences and uncertainties in the book inventory.

Article 73

Subject to the procedures laid down in Article 77, the Agency may make special inspections:

(a) In order to verify the information contained in special reports; or

(b) If the Agency considers that information made available by the Government of the G. D. R. including explanations from the Government of the G. D. R. and information obtained from routine inspections, is not adequate for the Agency to fulfil its responsibilities under this Agreement.

An inspection shall be deemed to be special when it is either additional to the routine inspection effort provided for in Articles 78-82 or involves access to information or locations in addition to the access specified in Article 76 for ad hoc and routine inspections, or both.

Scope of inspections

Article 74

For the purposes specified in Articles 71-73, the Agency may:

(a) Examine the records kept pursuant to Articles 51-58;

(b) Make independent measurements of all nuclear material subject to safeguards under this Agreement;

(c) Verify the functioning and calibration of instruments and other measuring and control equipment;

(d) Apply and make use of surveillance and containment measures; and

(e) Use other objective methods which have been demonstrated to be technically feasible.

Article 75

Within the scope of Article 74, the Agency shall be enabled:

(a) To observe that samples at key measurement points for material balance accountancy are taken in accordance with procedures which produce representative samples, to observe the treatment and analysis of the samples and to obtain duplicates of such samples;

(b) To observe that the measurements of nuclear material at key measurement points for material balance accountancy are representative, and to observe the calibration of the instruments and equipment involved;

(c) To make arrangements with the Government of the G. D. R. that, if necessary:

  (i) Additional measurements are made and additional samples taken for the Agency's use;

  (ii) The Agency's standard analytical samples are analysed;

  (iii) Appropriate absolute standards are used in calibrating instruments and other equipment; and

  (iv) Other calibrations are carried out;

(d) To arrange to use its own equipment for independent measurement and surveillance, and if so agreed and specified in the Subsidiary Arrangements to arrange to install such equipment;

(e) To apply its seals and other identifying and tamper-indicating devices to containments, if so agreed and specified in the Subsidiary Arrangements; and

(f) To make arrangements with the Government of the G. D. R. for the shipping of samples taken for the Agency's use.

Access for inspections

Article 76

(a) For the purposes specified in Article 71(a) and (b) and until such time as the strategic points have been specified in the Subsidiary Arrangements, the Agency inspectors shall have access to any location where the initial report or any inspections carried out in connection with it indicate that nuclear material is present;

(b) For the purposes specified in Article 71(c) the inspectors shall have access to any location of which the Agency has been notified in accordance with Articles 92(d)(iii) or 95(d)(iii);

(c) For the purposes specified in Article 72 the inspectors shall have access only to the strategic points specified in the Subsidiary Arrangements and to the records maintained pursuant to Articles 51-58; and

(d) In the event of the Government of the G. D. R. concluding that any unusual circumstances require extended limitations on access by the Agency, the Government of the G. D. R. and the Agency shall promptly make arrangements with a view to enabling the Agency to discharge its safeguards responsibilities in the light of these limitations. The Director General shall report each such arrangement to the Board.

Article 77

In circumstances which may lead to special inspections for the purposes specified in Article 73 the Government of the G. D. R. and the Agency shall consult forthwith. As a result of such consultations the Agency may:

(a) Make inspections in addition to the routine inspection effort provided for in Articles 78-82; and

(b) Obtain access, in agreement with the Government of the G. D. R., to information or locations in addition to those specified in Article 76. Any disagreement concerning the need for additional access shall be resolved in accordance with Articles 21 and 22; in case action by the Government of the G. D. R. is essential and urgent, Article 18 shall apply.

Frequency and intensity of routine inspections

Article 78

The Agency shall keep the number, intensity and duration of routine inspections, applying optimum timing, to the minimum consistent with the effective implementation of the safeguards procedures set forth in this Agreement, and shall make the optimum and most economical use of inspection resources available to it.

Article 79

The Agency may carry out one routine inspection per year in respect of facilities and material balance areas outside facilities with a content or annual throughput, whichever is greater, of nuclear material not exceeding five effective kilograms.

Article 80

The number, intensity, duration, timing and mode of routine inspections in respect of facilities with a content or annual throughput of nuclear material exceeding five effective kilograms shall be determined on the basis that in the maximum or limiting case the inspection regime shall be no more intensive than is necessary and sufficient to maintain continuity of knowledge of the flow and inventory of nuclear material, and the maximum routine inspection effort in respect of such facilities shall be determined as follows:

(a) For reactors and sealed storage installations the maximum total of routine inspection per year shall be determined by allowing one sixth of a man-year of inspection for each such facility;

(b) For facilities, other than reactors or sealed storage installations, involving plutonium or uranium enriched to more than 5%, the maximum total of routine inspection per year shall be determined by allowing for each such facility $30 \times \sqrt{E}$ man-days of inspection per year, where E is the inventory or annual throughput of nuclear material, whichever is greater, expressed in effective kilograms. The maximum established for any such facility shall not, however, be less than 1.5 man-years of inspection; and

(c) For facilities not covered by paragraphs (a) or (b), the maximum total of routine inspection per year shall be determined by allowing for each such facility one third of a man-year of inspection plus $0.4 \times E$ man-days of inspection per year, where E is the inventory or annual throughput of nuclear material, whichever is greater, expressed in effective kilograms.

The Government of the G. D. R. and the Agency may agree to amend the figures for the maximum inspection effort specified in this Article, upon determination by the Board that such amendment is reasonable.

Article 81

Subject to Articles 78-80 the criteria to be used for determining the actual number, intensity, duration, timing and mode of routine inspections in respect of any facility shall include:

(a) The form of the nuclear material, in particular, whether the nuclear material is in bulk form or contained in a number of separate items; its chemical composition and, in the case of uranium, whether it is of low or high enrichment; and its accessibility;

(b) The effectiveness of the G. D. R.'s accounting and control system, including the extent to which the operators of facilities are functionally independent of the G. D. R.'s accounting and control system; the extent to which the measures specified in Article 32 have been implemented by the G. D. R.; the promptness of reports provided to the Agency; their consistency with the Agency's independent verifications; and the amount and accuracy of the material unaccounted for, as verified by the Agency;

(c) Characteristics of the G. D. R.'s nuclear fuel cycle, in particular, the number and types of facilities containing nuclear material subject to safeguards, the characteristics of such facilities relevant to safeguards, notably the degree of containment, the extent to which the design of such facilities facilitates verification of the flow and inventory of nuclear material; and the extent to which information from different material balance areas can be correlated;

(d) International interdependence, in particular, the extent to which nuclear material is received from or sent outside the G. D. R. for use or processing; any verification activities by the Agency in connection therewith; and the extent to which the G. D. R.'s nuclear activities are interrelated with those outside the G. D. R.; and

(e) Technical developments in the field of safeguards, including the use of statistical techniques and random sampling in evaluating the flow of nuclear material.

Article 82

The Government of the G. D. R. and the Agency shall consult if the Government of the G. D. R. considers that the inspection effort is being deployed with undue concentration on particular facilities.

Notice of inspections

Article 83

The Agency shall give advance notice to the Government of the G. D. R. before arrival of inspectors at facilities or material balance areas outside facilities, as follows:

(a) For ad hoc inspections pursuant to Article 71(c), at least 24 hours; for those pursuant to Article 71(a) and (b) as well as the activities provided for in Article 48, at least one week;

(b) For special inspections pursuant to Article 73, as promptly as possible after the Government of the G. D. R. and the Agency have consulted as provided for in Article 77, it being understood that notification of arrival normally will constitute part of the consultations; and

(c) For routine inspections pursuant to Article 72, at least 24 hours in respect of the facilities referred to in Article 80(b) and sealed storage installations containing plutonium or uranium enriched to more than 5%, and one week in all other cases.

Such notice of inspections shall include the names of the inspectors and shall indicate the facilities and the material balance areas outside facilities to be visited and the periods during which they will be visited. If the inspectors are to arrive from outside the G. D. R. the Agency shall also give advance notice of the place and time of their arrival in the G. D. R.

Article 84

Notwithstanding the provisions of Article 83, the Agency may, as a supplementary measure, carry out without advance notification a portion of the routine inspections pursuant to Article 80 in accordance with the principle of random sampling. In performing any unannounced inspections, the Agency shall fully take into account any operational programme provided by the Government of the G. D. R. pursuant to Article 64(b). Moreover, whenever practicable, and on the basis of the operational programme, it shall advise the Government of the G. D. R. periodically of its general programme of announced and unannounced inspections, specifying the general periods when inspections are foreseen. In carrying out any unannounced inspections, the Agency shall make every effort to minimize any practical difficulties for the Government of the G. D. R. and for facility operators, bearing in mind the relevant provisions of Articles 44 and 89. Similarly the Government of the G. D. R. shall make every effort to facilitate the task of the inspectors.

Designation of inspectors

Article 85

The following procedures shall apply to the designation of inspectors:

(a) The Director General shall inform the Government of the G. D. R. in writing of the name, qualifications, nationality, grade and such other particulars as may be relevant, of each Agency official he proposes for designation as an inspector for the G. D. R.;

(b) The Government of the G. D. R. shall inform the Director General within thirty days of the receipt of such a proposal whether it accepts the proposal;

(c) The Director General may designate each official who has been accepted by the Government of the G. D. R. as one of the inspectors for the G. D. R., and shall inform the Government of the G. D. R. of such designations; and

(d) The Director General, acting in response to a request by the Government of the G. D. R. or on his own initiative, shall immediately inform the Government of the G. D. R. of the withdrawal of the designation of any official as an inspector for the G. D. R.

However, in respect of inspectors needed for the activities provided for in Article 48 and to carry out ad hoc inspections pursuant to Article 71(a) and (b) the designation procedures shall be completed if possible within thirty days after the entry into force of this Agreement. If such designation appears impossible within this time limit, inspectors for such purposes shall be designated on a temporary basis.

Article 86

The Government of the G. D. R. shall grant or renew as quickly as possible appropriate visas, where required, for each inspector designated for the G. D. R.

Conduct and visits of inspectors

Article 87

Inspectors, in exercising their functions under Articles 48 and 71-75, shall carry out their activities in a manner designed to avoid hampering or delaying the construction, commissioning or operation of facilities, or affecting their safety. In particular inspectors shall not operate any facility themselves or direct the staff of a facility to carry out any operation. If inspectors consider that in pursuance of Articles 74 and 75, particular operations in a facility should be carried out by the operator, they shall make a request therefor.

Article 88

When inspectors require services available in the G. D. R., including the use of equipment, in connection with the performance of inspections, the Government of the G. D. R. shall facilitate the procurement of such services and the use of such equipment by inspectors.

Article 89

The Government of the G. D. R. shall have the right to have inspectors accompanied during their inspections by representatives of the Government of the G. D. R., provided that inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

STATEMENTS ON THE AGENCY'S VERIFICATION ACTIVITIES

Article 90

The Agency shall inform the Government of the G. D. R. of:

(a) The results of inspections, at intervals to be specified in the Subsidiary Arrangements; and

(b) The conclusions it has drawn from its verification activities in the G. D. R., in particular by means of statements in respect of each material balance area, which shall be made as soon as possible after a physical inventory has been taken and verified by the Agency and a material balance has been struck.

INTERNATIONAL TRANSFERS

General provisions

Article 91

Nuclear material subject or required to be subject to safeguards under this Agreement which is transferred internationally shall, for purposes of this Agreement, be regarded as being the responsibility of the Government of the G. D. R.:

(a) In the case of import into the G. D. R., from the time that such responsibility ceases to lie with the exporting State, and no later than the time at which the material reaches its destination; and

(b) In the case of export out of the G. D. R., up to the time at which the recipient State assumes such responsibility, and no later than the time at which the nuclear material reaches its destination.

The point at which the transfer of responsibility will take place shall be determined in accordance with suitable arrangements to be made by the Governments concerned. Neither the Government of the G. D. R. nor any other Government shall be deemed to have such responsibility for nuclear material merely by reason of the fact that the nuclear material is in transit on or over its territory, or that it is being transported on a ship under its flag or in its aircraft.

Transfers out of the G. D. R.

Article 92

(a) The Government of the G. D. R. shall notify the Agency of any intended transfer out of the G. D. R. of nuclear material subject to safeguards under this Agreement if the shipment exceeds one effective kilogram, or if, within a period of three months, several separate shipments are to be made to the same State, each of less than one effective kilogram but the total of which exceeds one effective kilogram.

(b) Such notification shall be given to the Agency after the conclusion of the contractual arrangements leading to the transfer and normally at least two weeks before the nuclear material is to be prepared for shipping.

(c) The Government of the G. D. R. and the Agency may agree on different procedures for advance notification.

(d) The notification shall specify:

- (i) The identification and, if possible, the expected quantity and composition of the nuclear material to be transferred, and the material balance area from which it will come;
- (ii) The State for which the nuclear material is destined;
- (iii) The dates on and locations at which the nuclear material is to be prepared for shipping;
- (iv) The approximate dates of dispatch and arrival of the nuclear material; and
- (v) At what point of the transfer the recipient State will assume responsibility for the nuclear material for the purpose of this Agreement, and the probable date on which that point will be reached.

Article 93

The notification referred to in Article 92 shall be such as to enable the Agency to make, if necessary, an ad hoc inspection to identify, and if possible verify the quantity and composition of, the nuclear material before it is transferred out of the G. D. R. and, if the Agency so wishes or the Government of the G. D. R. so requests, to affix seals to the nuclear material when it has been prepared for shipping. However, the transfer of the nuclear material shall not be delayed in any way by any action taken or contemplated by the Agency pursuant to such a notification.

Article 94

If the nuclear material will not be subject to Agency safeguards in the recipient State, the Government of the G. D. R. shall make arrangements for the Agency to receive, within three months of the time when the recipient State accepts responsibility for the nuclear material from the G. D. R., confirmation by the recipient State of the transfer.

Transfers into the G. D. R.

Article 95

(a) The Government of the G. D. R. shall notify the Agency of any expected transfer into the G. D. R. of nuclear material required to be subject to safeguards under this Agreement if the shipment exceeds one effective kilogram, or if, within a period of three months, several separate shipments are to be received from the same State, each of less than one effective kilogram but the total of which exceeds one effective kilogram.

(b) The Agency shall be notified as much in advance as possible of the expected arrival of the nuclear material, and in any case not later than the date on which the Government of the G. D. R. assumes responsibility for the nuclear material.

(c) The Government of the G. D. R. and the Agency may agree on different procedures for advance notification.

(d) The notification shall specify:

(i) The identification and, if possible, the expected quantity and composition of the nuclear material;

(ii) At what point of the transfer the Government of the G. D. R. will assume responsibility for the nuclear material for the purpose of this Agreement, and the probable date on which that point will be reached; and

(iii) The expected date of arrival, the location where, and the date on which, the nuclear material is intended to be unpacked.

Article 96

The notification referred to in Article 95 shall be such as to enable the Agency to make, if necessary, an ad hoc inspection to identify, and if possible verify the quantity and composition of, the nuclear material at the time the consignment is unpacked. However, unpacking shall not be delayed by any action taken or contemplated by the Agency pursuant to such a notification.

Special reports

Article 97

The Government of the G. D. R. shall make a special report as envisaged in Article 68 if any unusual incident or circumstances lead the Government of the G. D. R. to believe that there is or may have been loss of nuclear material, including the occurrence of significant delay, during an international transfer.

DEFINITIONS

Article 98

For the purposes of this Agreement:

A. Adjustment means an entry into an accounting record or a report showing a shipper/receiver difference or material unaccounted for.

B. Annual throughput means, for the purposes of Articles 79 and 80, the amount of nuclear material transferred annually out of a facility working at nominal capacity.

C. Batch means a portion of nuclear material handled as a unit for accounting purposes at a key measurement point and for which the composition and quantity are defined by a single set of specifications or measurements. The nuclear material may be in bulk form or contained in a number of separate items.

D. Batch data means the total weight of each element of nuclear material and, in the case of plutonium and uranium, the isotopic composition when appropriate. The units of account shall be as follows:

(a) Grams of contained plutonium;

(b) Grams of total uranium and grams of contained uranium-235 plus uranium-233 for uranium enriched in these isotopes; and

(c) Kilograms of contained thorium, natural uranium or depleted uranium.

For reporting purposes the weights of individual items in the batch shall be added together before rounding to the nearest unit.

E. Book inventory of a material balance area means the algebraic sum of the most recent physical inventory of that material balance area and of all inventory changes that have occurred since that physical inventory was taken.

F. Correction means an entry into an accounting record or a report to rectify an identified mistake or to reflect an improved measurement of a quantity previously entered into the record or report. Each correction must identify the entry to which it pertains.

G. Effective kilogram means a special unit used in safeguarding nuclear material. The quantity in effective kilograms is obtained by taking:

(a) For plutonium, its weight in kilograms;

(b) For uranium with an enrichment of 0.01 (1%) and above, its weight in kilograms multiplied by the square of its enrichment;

(c) For uranium with an enrichment below 0.01 (1%) and above 0.005 (0.5%), its weight in kilograms multiplied by 0.0001; and

(d) For depleted uranium with an enrichment of 0.005 (0.5%) or below, and for thorium, its weight in kilograms multiplied by 0.00005.

H. Enrichment means the ratio of the combined weight of the isotopes uranium-233 and uranium-235 to that of the total uranium in question.

I. Facility means:

(a) A reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or

(b) Any location where nuclear material in amounts greater than one effective kilogram is customarily used.

J. Inventory change means an increase or decrease, in terms of batches, of nuclear material in a material balance area; such a change shall involve one of the following:

(a) Increases:

  (i) Import;

  (ii) Domestic receipt: receipts from other material balance areas, receipts from a non-safeguarded (non-peaceful) activity or receipts at the starting point of safeguards;

  (iii) Nuclear production: production of special fissionable material in a reactor; and

  (iv) De-exemption: re-application of safeguards on nuclear material previously exempted therefrom on account of its use or quantity.

(b) Decreases:

  (i) Export;

  (ii) Domestic shipment: shipments to other material balance areas or shipments for a non-safeguarded (non-peaceful) activity;

  (iii) Nuclear loss: loss of nuclear material due to its transformation into other element(s) or isotope(s) as a result of nuclear reactions;

  (iv) Measured discard: nuclear material which has been measured, or estimated on the basis of measurements, and disposed of in such a way that it is not suitable for further nuclear use;

  (v) Retained waste: nuclear material generated from processing or from an operational accident, which is deemed to be unrecoverable for the time being but which is stored;

  (vi) Exemption: exemption of nuclear material from safeguards on account of its use or quantity; and

  (vii) Other loss: for example, accidental loss (that is, irretrievable and inadvertent loss of nuclear material as the result of an operational accident) or theft.

K. Key measurement point means a location where nuclear material appears in such a form that it may be measured to determine material flow or inventory. Key measurement points thus include, but are not limited to, the inputs and outputs (including measured discards) and storages in material balance areas.

L. Man-year of inspection means, for the purposes of Article 80, 300 man-days of inspection, a man-day being a day during which a single inspector has access to a facility at any time for a total of not more than eight hours.

M. Material balance area means an area in or outside of a facility such that:

(a) The quantity of nuclear material in each transfer into or out of each material balance area can be determined; and

(b) The physical inventory of nuclear material in each material balance area can be determined when necessary, in accordance with specified procedures,

in order that the material balance for Agency safeguards purposes can be established.

N. Material unaccounted for means the difference between book inventory and physical inventory.

O. Nuclear material means any source or any special fissionable material as defined in Article XX of the Statute. The term source material shall not be interpreted as applying to ore or ore residue. Any determination by the Board under Article XX of the Statute after the entry into force of this Agreement which adds to the materials considered to be source material or special fissionable material shall have effect under this Agreement only upon acceptance by the Government of the G.D.R.

P. Physical inventory means the sum of all the measured or derived estimates of batch quantities of nuclear material on hand at a given time within a material balance area, obtained in accordance with specified procedures.

Q. Shipper/receiver difference means the difference between the quantity of nuclear material in a batch as stated by the shipping material balance area and as measured at the receiving material balance area.

R. Source data means those data, recorded during measurement or calibration or used to derive empirical relationships, which identify nuclear material and provide batch data. Source data may include, for example, weight of compounds, conversion factors to determine weight of element, specific gravity, element concentration, isotopic ratios, relationship between volume and manometer readings and relationship between plutonium produced and power generated.

S. Strategic point means a location selected during examination of design information where, under normal conditions and when combined with the information from all strategic points taken together, the information necessary and sufficient for the implementation of safeguards measures is obtained and verified; a strategic point may include any location where key measurements related to material balance accountancy are made and where containment and surveillance measures are executed.

DONE in Vienna on the seventh day of March 1972 in duplicate in the English language.

For the GOVERNMENT OF THE GERMAN DEMOCRATIC REPUBLIC:

(signed) Ewald Moldt

For the INTERNATIONAL ATOMIC ENERGY AGENCY:

(signed) Sigvard Eklund

APPENDIX 7

OUTLINE OF FACILITY ATTACHMENT FOR CIRCULAR 153 SAFEGUARDS

Explanatory Note

The Model does not claim to be exhaustive and, therefore, it should not be expected to meet every conceivable situation at a PWR/BWR. It does, however, cater for situations at most plants of this type. In preparing a facility attachment for a specific PWR/BWR, therefore, this must be borne in mind and the relevant codes must be appropriately reworded to take care of any unusual or special circumstance.

The containment and surveillance measures mentioned in Code 3.2.2 of the Model should be regarded as illustrative and not obligatory. Its text would depend on the specific containment and surveillance devices agreed upon and applicable. For example, at some plants it might be possible to seal each fuel assembly during fabrication, at others it might be possible to seal the fuel store, at yet some others it might be possible to seal the irradiated fuel storage, etc.

This Model has been prepared for a power station with one reactor unit. It is adaptable for a station with two reactor units constituting either one MBA or two separate MBAs, one for each unit. In the event the entire station is treated as one MBA, the procedure for the physical verification of the inventory is that the Agency inspects the refuelling of the reactor which is done first in a calendar year, verifies its core and seals the reactor. Thereafter at the time of the refuelling of the second reactor, it verifies the complete physical inventory, i.e., all the fresh fuel, all the irradiated fuel and the fuel that goes into the second open reactor, and it also ensures that the seal on the fuel in the first reactor is not tampered with.

In Code 4.1, KMP 2, the production of fissile uranium is relevant only if thorium is irradiated in the reactor core.

Secretariat Draft

M-02
(PWR - BWR)

Safeguards Agreement under NPT between [ ] and the IAEA
Subsidiary Arrangements

Facility Attachment No. ; (name of the facility)
Facility: ; MBA:
Total No. of pages 15 ; Page No. 1 Date: January 1975

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
1.		43(a)[1]	Identification of the facility Facility identification code:
1.1			Name, owner and operator Nuclear Power Station, owner and operator -
1.2			Geographic location
1.3			Postal address
1.4			Description The power station consists of one [direct/dual cycle] [boiling] [pressurised] light water reactor, MW(th).
1.5			Maps and plans Attached herewith.
2.	3.1.1	43,44, 46(a)	Information on the facility This facility attachment is based on the Design Information provided by as of
2.1		8(c)	Location of information Identical sets of the information provided on the facility are kept at the Agency, at the facility and at

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[1] The references to the Articles of the Agreement may differ for different countries, and should be checked by the Country Officer.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
2.2	3.1.3	45	Changes in the information on the facility to be provided in advance (With reference to the relevant paragraphs of the design information provided) [2] - Change in the rated thermal output for continuous operation; - Changes in the access routes to the reactor area; - Changes in the design of the reactor fuel; - Change in the nominal enrichments of the fuel; - Changes of the method of identifying individual fuel assemblies; - Changes of the refuelling equipment or methods; - Any change in connection with the reactor vessel or its cover influencing access to the core; - Installation of equipment for assembling or disassembling fuel assemblies (for fuel pin exchange); - Introduction of new irradiation positions inside the reactor vessel. - Introduction of new loop heat removal equipment; - Installation of any fuel assembly decladding or dissolution equipment; - Change in the routes of the shipping cask for irradiated fuel within the facility; - Any change in the health and safety procedures affecting the conduct of inspection.
3.			Safeguards measures
3.1		29	Accountancy
3.1.1		46(b)	Material balance areas and their identification codes. The reactor facility, , constitutes one material balance area - MBA

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[2] Paragraph numbers will be quoted against each item.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
3.1.2		46(b) 98K 98S	Strategic points which are key measurement points (KMPs) (for their specifications see Code 4). (a) For determination of nuclear material flow: KMP 1 - Receipt and de-exemption of nuclear material KMP 2 - Shipment of nuclear material, exemption nuclear production, nuclear loss and accidental loss. (b) For determination of physical inventory: KMP A - Fresh fuel storage KMP B - Fuel in the reactor core KMP C - Spent fuel storage KMP D - Other locations of nuclear material at the facility.
3.1.3		46(c)	Physical inventory taking and verification. Nominal timing: As soon as possible after each refuelling and before the reactor is closed again. Procedures: Item counting. Identification except for items in the core. Use of containment and surveillance methods for the reactor vessel, whose contents have been checked previously.
3.2		29	Containment and surveillance
3.2.1		46(f) 98S	Strategic points for application of containment and surveillance measures: - Reactor hall - Access routes to the reactor hall, including the spent fuel pond.
3.2.2		75(d) 75 (e)	Installed Agency instruments and devices: [3] (a) seals to ensure the containment of the reactor vessel; (b) Camera(s) for surveillance of fuel movements into our out of the reactor containment, including the spent fuel pond.

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[3] These depend on the containment and surveillance measures agreed upon and which are applicable.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
			If there is a need to break a seal or interfere with the operation of safeguards instruments, the Agency shall be informed in advance and by the fastest means. This information shall include the (probable) date on which the operation will take place.
3.3		11 35(a)	Specific provisions and criteria for termination of safeguards on nuclear material None.
3.4		36	Specific provisions and criteria for exempting nuclear material from safeguards None.

Code 4

Agreement References (Articles): 57, 98C, 98R
Specifications for key measurement points.

Code 4.1 KMPs for the flow of nuclear materials

KMP	Inventory change	Description of a typical		Source data	Material description	Measurement basis
		batch	item			
1	Receipt	For fuel assemblies: One fuel assembly	One fuel assembly	For each fuel assembly: 1) Identification number 2) Weights of total and fissile uranium 4/(and of plutonium) and the chemical composition based on shipper's data.	EA0F	N
		For fuel rods: A number of separate fuel rods received in one consignment	One fuel rod	For each fuel rod: 1) Identification number 2) Weights of total and fissile uranium 4/(and of plutonium) and the chemical composition based on shipper's data.	ER0F	N
		For small quantities of nuclear material (each less than 0.01 effective kilogram): Any number of such quantities received in one calendar month from the same shipper or, if a physical inventory was taken during the month, separately before and after the time of physical inventory taking.	Not applicable	1) Weight of compound 2) Weights of total and fissile uranium and the chemical composition based on shipper's data.	SS0F	N

4/ Note: (and of plutonium) valid only for fuel containing recycled plutonium

Code 4.1 KMPs for the flow of nuclear materials (continued)

KMP	Inventory change	Description of a typical		Source data	Material description	Measurement basis
		batch	item			
2	Nuclear production	For fuel assemblies: All fuel assemblies shipped together.	One fuel assembly	1)-2) As for fuel assemblies at KMP 1 above. 3) Estimated burn-up of each fuel assembly shipped (in MWD/tU). 4) Nuclear loss and production, of total and fissile uranium and total plutonium as calculated for each fuel assembly shipped. 5) Weights and, if available, isotopic composition of total and fissile uranium and weight of total plutonium in each fuel assembly as calculated to allow for nuclear loss and production	EA0F EA0I	N M
	Shipment Nuclear loss	For fuel assemblies: One fuel assembly shipped.				
	Shipment Nuclear production Nuclear loss	For separate fuel rods: A number of separate fuel rods shipped together.	One fuel rod	For each fuel rod: 1) Identification number of fuel assembly from which the fuel rod was removed. 2) As for fuel rod at KMP 1 above. 3) Nuclear loss and production as calculated for each fuel rod shipped. 4) Weights and, if available, isotopic composition of total and fissile uranium and weight of total plutonium in each fuel rod shipped, as calculated to allow for nuclear loss and production.	ER0F ER0I	N M

Code 4.1 KMPs for the flow of nuclear material (continued)

KMP	Inventory change	Description of a typical		Source data	Material description	Measurement basis
		batch	item			
2	Shipment Nuclear production Nuclear loss	For small quantities of nuclear material (each less than 0.01 effective kilogram): Any number of such quantities shipped in one calendar month to the same recipient or, if a physical inventory was taken during that month, separately before and after the time of physical inventory taking.	Not applicable	1) Weight of compound 2) Weights of total and fissile uranium and chemical composition as given by the operator.	SS0F SS0I	N M
	Exemption Accidental loss	The same as for shipments or receipts, respectively				
1	De-exemption					

Code 4.2 KMPs for the physical inventory of nuclear material

KMP	Description of a typical		Source data	Material description	Measurement basis
	batch	item			
A	For fuel assemblies: One fuel assembly	One fuel assembly	For each fuel assembly: 1) Identification number 2) Weights of total and fissile uranium and the chemical composition based on shipper's data.	EA0F EA0I	N N
B	For fuel rods: Any number of separate fuel rods	One fuel rod	For each fuel rod: 1) Identification number 2) Weights of total and fissile uranium and the chemical composition based on shipper's data.	ER0F ER0I	N N
C	For small quantities of nuclear materials (each less than 0.01 effective kilogram): Any number of such quantities.	Not applicable	1) Weight of compound 2) Weights of total and fissile uranium based on shipper's data.	SS0F SS0I	N N

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
5		46(d), 51	Records system
5.1		56	Specific provisions for accounting records
5.1.1		56(a), 98D	Inventory changes (for the specifications of source data see Code 4.1 above), time of recording. - Receipts (KMP 1): Upon receipt. - Nuclear loss and nuclear production (KMP 2): For irradiated material, upon shipment. - Shipment (KMP 2): Upon shipment.
	6.3, 6.2		- Exemption/de-exemption (KMP 2/KMP 1) Upon transfer of nuclear material out of/into the facility respectively. - Accidental loss (KMP 2) Upon determining the amount of the loss.
5.1.2	4.2	56(b), 98D	Measurement (item counting and identification) results used for determination of the physical inventory (for the specifications of source data see Code 4.2 above), time of recording. - All physical inventory KMPs Upon identification and counting of items during the physical inventory taking.
5.1.3		56(c)	Adjustments and corrections, time of recording. - Shipper/receiver difference (KMP 1): Not relevant. - MUF Normally identical to zero. - Corrections Whenever errors have been found
5.2		58	Specific provisions for operating records
5.2.1		58(a)	Operating data used to establish changes in the quantities and composition of nuclear material. - Location of each fuel assembly or separate fuel pin at any time; - The relevant source data with respect to nuclear loss and production, including: (a) The integrated thermal power produced by the reactor - once per [day] [shift]; and

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
5.2.1 (cont)			(b) The estimated burn-up (in MWD/t) for each fuel assembly [after its final discharge 5/ from the reactor] [at least whenever a refuelling takes place]. - Date and duration of any reactor shut-down; - Date and description of any dismantling operation of a fuel assembly.
5.2.2		58(b)	Calibrations. Not required.
5.2.3		58(c)	Sequence of the actions taken in preparing for and in taking the physical inventory. - All physical inventory KMPs: Dates and description of the actions taken and the results obtained.
5.2.4		58(d)	Actions taken in order to ascertain the cause and magnitude of any accidental or unmeasured loss: - Dates and description of the actions taken and the results obtained.
5.3		52	Location and language of records At the facility.
5.4		53	Retention period for records Five years.
6.		46(d), 59	Reports system
6.1	3.4.1	63(a), 64 65	Specific provisions for inventory change reports (ICRs)
6.1.1	10	98D	Contents. The inventory changes to be reported are those types specified in Code 5.1.1 above. Nuclear loss and production will be reported only upon shipment in the same ICR where the shipment is reported. The element code of the initial fuel category will be used in reporting. Forms R.01.1/c will be completed as specified in paragraphs 1-23 of Code 10, General Part. However, Forms R.01.2 will be completed as specified in paragraphs 1-28 of Code 10, General Part, to report shipments of irradiated fuel assemblies, in respect of which the isotopic composition is available.

5/ This applies in the case of Pu recycling.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
6.1.2			Timing or frequency of dispatch. Within 30 days after the end of the month in which receipt, shipment, exemption, de-exemption or accidental loss occurred or was established.
6.2	3.4.1	64	Specific provisions for concise notes
6.2.1		64(a)	Concise notes explaining the inventory changes: - To be attached to each ICR containing the data on nuclear loss and production to state the burn-up in MWD/t of initial U for each fuel batch shipped; - To be attached to ICRs to explain unusual inventory changes (such as accidental loss) and corrections. They may also be used to explain any other part of information included in reports.
6.2.2		64(b)	Concise notes describing the anticipated operational programme; subject and time of dispatch: - Planned operations involving the removal of the reactor vessel seal, e.g. refuelling and fresh fuel receipts and spent fuel shipments; To be attached to each MBR (see Code 6.3.3 below) and to cover the period until the end of the next refuelling. - Precise forecast for the next refuelling, physical inventory taking or spent fuel shipment: To reach the Agency at least 30 days in advance, subsequent changes thereto as soon as they are known. - Dates and identification numbers of fuel assemblies involved in any planned dismantling operation: Normally to reach the Agency at least 30 days in advance.
6.3	3.4.2	63(b),67	Specific provisions for material balance reports (MBRs)
6.3.1	10	98D	Contents. The consolidated inventory changes to be reported are those types specified in Code 5.1.1 above. Nuclear loss and production will only be reported in respect of reactor fuel shipped from the facility. Forms R.03 will be completed, as specified in paragraphs 44-54 of Code 10, General Part.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
6.3.2	10	98D	Physical inventory listings (PILs) to be attached to MBRs: The batch data included in PILs will be based on the shipper's data on the initial nuclear material content of the fuel. Forms R.02/c will be completed, as specified in paragraphs 29-43 of Code 10, General Part.
6.3.3			Timing or frequency of dispatch: Within 30 days of the physical inventory taking under Code 3.1.3 above.
6.4	3.5.1	68	Special reports
6.4.1			Specification of circumstances requiring submission of special reports. (a) Loss limits: One fuel element (rod). (b) Changes in containment: - Physical integrity of a fuel assembly as an accounting unit is accidentally broken; - Any Agency containment and surveillance device, referred to in Code 3.2.2 such as a seal or camera, is interfered with or removed in the absence of Agency inspectors, unless the Agency has been informed in advance as provided.
6.4.2			Contents, as appropriate. - Date when the incident or circumstance occurred; - Description of the actions taken in order to ascertain the cause of the incident or circumstance and the magnitude of the loss; - Cause and features of the incident or circumstance; - Estimated amount of nuclear material which has been lost.
7.			Inspections
7.1		78,80	Mode of routine inspections Intermittent.
7.2	Annex	80	Applicable formula and procedure for determination of maximum routine inspection effort Article 80 (a) of the Agreement.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
7.3		78,81	Indication of the actual inspection effort under ordinary circumstances
			An estimate of the actual routine inspection effort, as far as can be foreseen and assuming:
	3.1		(a) Circumstances at the facility to be as described in the information provided in respect of the facility; and
	2		(b) The continued validity of the information on the national system of accounting for and control of nuclear material, as set out in the General Part.
			man-days per year assuming one refuelling. [6]
7.4		74,75	Indication of the scope of routine inspections under ordinary circumstances
7.4.1			General: - Examination of the records, verification for self-consistency and consistency with reports.
7.4.2			At inventory KMPs: - Verification of the inventory, e.g. by item counting, identification and integrity checks, non-destructive measurements.
7.4.3			At flow KMPs: - Verification of inventory changes, e.g. by item counting, identification and integrity checks, non-destructive measurements of fresh and irradiated fuel, including the use of seals on containers of fresh and irradiated fuel.
7.4.4			At strategic points for containment and surveillance (reactor hall and access routes thereto): - Observation of refuelling and spent fuel removal operations; - Observation of dismantling of fuel assemblies; - Application, examination and exchange of Agency seals used in accordance with Code 3.2.2. - Servicing and maintenance of the surveillance equipment.

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[6] In determining the actual routine inspection effort consideration should be given to the frequency of refuelling and the containment and surveillance methods which are applied.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
7.5		75(d)	Arrangements for the use by the Agency of equipment for independent measurement Specific arrangements for the use of equipment to be made as the need arises.
7.6	9.4	75(a), 75(c)(i)	Duplicates and additional samples Not relevant.
7.7		87,88	Persons to whom a request for any operation or for services at the facility should be addressed Contacts at the facility
7.9		15,88	Services and charges
7.9.1			Services provided by the operator free of charge. - Health and safety services (protective clothing, dosimeters); - Office space for the Agency's inspectors; - Power supply for the Agency instruments; - Personnel for handling the fuel assemblies during their measurements; - Available equipment for handling the fuel assemblies during their measurements.
7.9.2			Services provided by the operator with the charges to the Agency, as quoted below. - Means of communication (telephone, telex, cable): according to existing rates. If any specific request by the Agency for services not covered above gives rise to expenses for which reimbursement is requested from the Agency, the Agency shall be notified of the expenses before the service is performed. The Agency will only reimburse such expenses if it has confirmed its initial request and agreed in writing to the amount involved.
7.9.3			Mode of reimbursement of the expenses charged to the Agency: - By cheque after receipt of the invoice by the Agency.

Code	General Part Reference (Codes)	Agreement Reference (Articles)	
7.10		44,89	Specific facility health and safety rules and regulations to be observed by the Agency's inspectors As specified in paragraph 31 of the Design Information provided by dated
8.	4.1.3	30,90	Agency statements
8.1		90(a)	A summary statement will be made on the result of each inspection within 30 days of its completion.
8.2		90(b)	A statement on the conclusions the Agency has drawn from its verification activities in respect of the facility will be made within 60 days after the end of the month in which the Agency has verified the physical inventory. The statement will include, as appropriate, conclusions drawn from: (a) Records examination; (b) Reports to the Agency; (c) Verification of containment and surveillance measures; (d) Verification of inventory changes; (e) Verification of material accountancy; (f) Verification of the quality and functioning of operator's measurement system; (g) Activities in respect of MUF, shipper/receiver differences and/or losses.

APPENDIX 8

S. I. P.

SAFEGUARDS IMPLEMENTATION PRACTICES

Page No. 1 of 9 pages
Date: 1975-04-24
Prepared by: S. Thorstensen
Distribution: "A"
Issue: "approved"

SIP OUTLINE

Approved: ....
Director, Division of Operations

(1) Indicates where modifications to the previous issue have been made.

GENERAL

The present SIP OUTLINE, together with the MODEL SIPS and the approved SAFEGUARDS IMPLEMENTATION MANUAL shall serve as a guide for the preparation of all SIPs.

SIPs for a given state or group of states shall normally consist of:

- a general part containing aspects which are common to all facilities or groups (types) of facilities in a state or states.
- a facility part[*/] for each facility containing aspects which are particular to the given facility.

Each part will be supplemented by "attachments" and a "Section Country/Facility Folder", as shown in Annex I.

(1) For a state where there are only a few nuclear facilities, the two parts may be combined at the discretion of the responsible Regional Section Chief.

The OUTLINE defines the general headings of the various sections of a typical SIP together with an explanation of the content of each section. As it covers both NPT and non-NPT situations, as well as a number of types of facilities, the outline alone can only serve as a general guide.

(1) The front page of each approved SIP shall be marked:

SAFEGUARDS CONFIDENTIAL - NO COPYING PERMITTED

Requests for additional copies of SIPs shall be made to the Director of the Division of Operations, who maintains a register of copies distributed and signatures of recipients.

All partial and complete provisional and draft editions of SIP shall be marked SAFEGUARDS CONFIDENTIAL.

All SIP documents shall be handled as defined in the valid Department of Safeguards and Inspection security instructions.

[*/] Read "facility" as "facility, MBA or convenient group of MBAs".

OUTLINE - GENERAL PART

1. List of Contents and Distribution

1.1 List of Contents

The list of contents will identify all valid sections, annexes and attachments included in the General Part of the SIP and, as appropriate, their date of issue or issue number. This section will also identify those parts (usually included in the form of attachments) which can be prepared, revised, approved and distributed by the Regional Section Chief. The title heading on the first page will be signed by the Director of the Division of Operations, and indicates his approval of the document.

(1) 1.2 List of Distribution

The SIP contains confidential information. Copies are made according to the approved SIP Documents Distribution List. All copies will be numbered and identified on the List of Distribution.

2. General Information and Instructions

2.1 Contacts

A list of names, addresses, telephone number and telex number of contacts with local authorities, the UNDP and other United Nations designated officials.

2.2 Health and Safety Matters

2.2.1 Routine. Give reference to the state's requirements (e.g. medical examinations, whole body counting, medical certificate from the IAEA) and provide instructions. List or give reference to "approved" local doctors and hospitals in the various parts of the state frequently visited by inspectors.

2.2.2 Emergency. The Agency, the local authorities and the "designated UN official" shall (have) work(ed) out procedures or guidelines for use in cases where inspectors are involved in:

- radiation accidents
- conventional accidents on and off facility premises
- civil disturbances
- abnormal situations where assistance is required.

This section will contain the required information or reference to such information (refer also to the corresponding section in the Facility Part(s).

2.3 Continuity of Knowledge

For countries/facilities with high inspection frequency, a description of how continuity of inspection information is ensured will be included. This will show:

- how the new inspection team receives up-to-date information even though formal inspection reports from previous inspections are not available.

- how information from the previous inspection team is communicated to the new team in cases where the two teams cannot meet, and how this information is made use of during the ensuing inspection.
- (e.g. through use of local log books).

2.4 Local Offices

In some states, DSI will have local offices, equipment stores, log books, etc. This section will then contain the appropriate instructions, e.g.:

- general and security instructions for office and storage (which may contain confidential material like files, seals, films).

2.5 Miscellaneous Instructions

- instructions for keeping inventory lists, maintenance schedules, equipment log books;
- instructions for shipment of samples (if not arranged by individual facilities);
- instructions for import and shipment of equipment;
- correspondence instructions.

2.6 Special Precautions

In some countries special conditions exist which require the inspector to take precautions to avoid difficulties (e.g. use of alcohol, racial and religious problems). A description or reference to sources of information shall be given.

3. Summary of Facilities

This section will give, in the form of an attachment, an up-to-date tabulation of facilities under safeguards in the state indicating category, type, facility name, planned inspection frequency and effort.

4. Basis for Safeguards Activities

This section will give references to applicable agreements, letters of understanding, notes to the file, etc.

The information will be presented as:

- that which is applicable to all facilities,
- that which is applicable to a given group of facilities (e.g. fuel fabrication plants, LWR, R & D laboratories, other locations).

Reference to basic documents like INFCIRC/153, The Inspectors' Document, need not be included.

Where required, the information will be supplemented by an explanation.

5. Information about the State's or States' System of Accounting and Control

This section will describe or make reference to a description of the technical and organizational aspects of the state's or states' system of accounting and control for nuclear materials. This should include possible co-ordination arrangements between state's or states' systems and Agency activities.

When appropriate, block diagrams or simple flow diagrams should be used to give a brief and clear presentation.

(1) 6. IAEA Safeguards Approach in the State

6.1 Survey of the Main Material Streams and Inspection Activities

Schematic presentation of the main interconnections between facilities in the state and an indication of some broad aspects of the methods employed by the Agency for the safeguards approach will be given in this section. Where applicable, verification of the findings of the state's or states' system should be included, with details of any activity carried out by inspectors in the central office for safeguards in the state and/or states.

6.2 Classification of the State According to the Characteristics of the Nuclear Fuel Cycle

6.3 Concealment Methods Connected with Nuclear Materials Transfers between Facilities

See the Background Material for Chapter 6 dated 1975-04-10.

6.4 Safeguards Approach with Respect to Nuclear Materials Transfers between Facilities

6.5 Limitations

(related to the safeguards approach described in section 6.4 above)

7. Section Country Folder

The designated Country Office shall maintain a "Section Country Folder."

This folder is to contain, inter alia, up-to-date information relevant to implementation procedures for all facilities in the country, presented in such a way that it can be utilized in the absence of the Country Officer.

It is recognized that the content of this folder will vary from country to country and also depend upon the initiative of the Country Officer.

OUTLINE - FACILITY PART

1. List of Contents and Distribution

As for section 1 of the General Part.

2. General Information and Instructions

2.1 Contacts

List names, addresses, telephone and telex number, purpose and procedures for contacting facility officials.

2.2 Health and Safety Matters

2.2.1 Routine. Make reference to facility requirements: for facilities where the IAEA has provided special monitors, protection equipment and medications, instructions shall be given or referred to in this section.

2.2.2 Emergency. Refer to section 2.2.2 of the General Part. Further instructions particular to the subject facility will be given.

2.3 Miscellaneous Instructions

Refer to section 2.5 of the General Part.

2.4 Instructions for Shipment of Samples

This section will describe the appropriate instructions for shipment of Agency samples.

2.5 Basis for Safeguards Activities

This section will give references to agreements, letters of understanding, and notes to the file particular to the subject facility which are specific and supplementary to those defined in section 4 of the General Part.

3. Facility Information

It is stressed that this section is not intended to duplicate the Design Information. It should contain that information which has the most direct relevance to safeguards implementation. Typical information (which may be confidential) could be:

3.1 Facility - Description and Place in the Fuel Cycle*/

Give a brief description of what function the facility has, its operating mode and its position in the fuel cycle. Whenever possible, use block diagrams and simple flow diagrams. If long-term contracts are established with related facilities in the fuel cycle, these shall be identified by name (e.g. supplier of nuclear materials, fuel fabrication plant, reprocessing plant, as the case may be).

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*/ Refer also to the appropriate chapters of IAEA/STR-1 (Rev. 1) December 1972

3.2 Description of Nuclear Materials Flow and Handling*/

Refer to or give a brief technical description of nuclear materials flow and handling. Accompany the description with diagrams where possible.

3.3 Internal Nuclear Materials Management*/

Refer to or describe (using references, annexed information, diagrams) the technical and organizational aspects of the internal "nuclear materials management" at the facility. This shall include a description and/or explanation of:

- the facility records system
- computer programmes or other methods of accounting for nuclear loss and production
- sampling and analytical practices
- information used in the determination of amounts of nuclear material, i.e. calibration
- internal/external quality control programmes
- preparation and routing of reports
- physical inventory policy,

where shortcomings or weak points are included.

The official facility records shall be listed by name and copies included as annexes. If required, headings and symbols used shall be translated into English.

4. Diversion Possibilities and Safeguards Approach

(1) 4.1 Diversion Possibilities and Means of Concealment

With the objectives of

- informing the inspector about the critical points, and
- providing background for appreciating the reasons behind the selected safeguards approach as outlined below:

4.1.1 List all the diversion possibilities.

4.1.2 List the concealment methods for the above diversion possibilities.

(1) 4.2 Safeguards Approach

4.2.1 The STM sets out the criteria and the range of safeguards approaches appropriate to each type of facility. This paragraph explains:

- which approach has been selected for the given facility
- why the selected approach was found to be the most suitable (taking into account its relation to other facilities in the fuel cycle).

If the objectives and approaches have not yet been defined by the STM in respect of the type of facility for which the SIP is being prepare, or if an unusual or incomplete approach or practice has to be followed, it is important that this is clearly pointed out and an explanation given.

In addition to the above description, a detailed listing of specific approaches selected to counter the diversion possibilities and means of concealment given in section 4.1 above shall be given.

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*/ Refer also to the appropriate chapters of IAEA/STR-1 (Rev. 1) December 1972

4.2.2 This paragraph explains the quantitative conclusions which can be drawn from the application of the safeguards approach given in 4.2.1 above (where appropriate).

(1) 4.3 Inspection Frequency and Effort

This section will contain details of the estimated (planned) inspection frequency and effort required in order to implement the "adopted safeguards approach" defined in section 4.2 above.

It may consist of a listing as shown below and may be included in the main text of the SIP or referred to as an attachment to the Facility Part or General Part, depending on the particular conditions.

Type of Inspection	Inspection Activities	Number of Inspectors	Planned Annual Inspection Frequency	Planned Annual Inspection Effort	Remarks

5. Facility Reports Evaluation Instructions

This section will define to what extent the Regional Sections shall evaluate the various types of facility reports submitted to the Agency under NPT and non-NPT conditions.

Again, it should be stressed that general instructions contained in the STM need not be repeated here, only those which are particular to the given facility.

SIP for non-NPT conditions shall describe the evaluation procedures currently practices.

For facilities subject to NPT agreements, the evaluation procedures currently prescribed in each Section should be listed. Guidelines for future evaluation procedures are being developed in the DD-2 Project and are to be adopted when available.

6. Preparation for Inspection

General pre-inspection activities are given in the STM and the DSI Manual. The additional activities required for the facility will be defined in this section, including e.g. the rationale for preparing:

- detailed inspection plans
- sampling plans
- field modification of inspection plans.

(1) 7. Inspection Activities

During an inspection one or more of the following inspection activities will be carried out:

- audit of accounting records
- audit of operating records
- comparison of accounting and operating records
- reconciliation of records and reports
- verification of inventory changes
- physical inventory verification
- interim inventory verification

- updating of book inventory
- installation/servicing of c/s devices or other instruments and/or
- collection/verification of information given by these devices
- other activities including verification of quality and functioning of the operator's measurement system and investigation of MUF and special reports.

The general explanation of these activities is given in the STM.

This section of the SIP should therefore be limited to specific directives applicable to this facility. These directives should be arranged according to inspection activity and described in enough detail to serve as a practical guide for the inspectors. It is emphasized that this section should contain those activities which are actually carried out and not those which may be carried out at some future date. It goes without saying that the activities described should be the most suitable which the actual circumstances permit.

(1) 8. Post-Inspection Activities

This section will cover those activities which are normally carried out at Headquarters by the Regional Sections. It includes:

- review/evaluation of the data collected by the inspector during his inspection
- continuous evaluation of selected key data at the facility.

For SIP covering non-NPT conditions, include the actual evaluation procedures.

For NPT conditions, the DD-2 Project is expected to develop clear guidelines which can be used for preparing evaluation instructions. Until these guidelines are available, this section of the SIP for NPT facilities should be based on actual evaluation procedures as in the case of non-NPT conditions.

9. Section Facility Folder

The designated Country/Facility Officer shall maintain a "Section Facility Folder." The purpose of the folder is to arrange for the systematic collection of up-to-date facility information and to provide easy access to this information when the Country/Facility Officer is absent.

This section will define the content of the Section Facility Folder. It is recognized that they will vary from facility to facility and also depend on the initiative of the Country/Facility Officer. Typical items which may be included are:

- a copy of the current SIP together with the latest editions of all SIP attachments
- a copy of information referred to in section 4 above
- calibration information
- inspection working papers
- diversion analysis (only the results of this analysis are required to be included in section 4.1 above)
- special investigations or follow-up actions required by the Country/Facility Officer
- brief notes giving pertinent current information about the facility and its operation.

10. Limitations

The purpose of this important section is to draw attention to those shortcomings in safeguards implementation at the facility which are apparent at the time of preparing the SIP. For some reason there may be a lack of standardization, inadequate inspection, lack of facility information, etc. This section will indicate where work remains to be done. It will also inform the Inspector General and the Director of the Division of Operations that the work is carried out with these shortcomings by the Regional Section.

The list of limitations can also be used as a check list and will remind the persons concerned to work toward improved conditions. When the situation changes, a revised SIP will have to be issued.

11. Attachments (Refer also to Annex I)

In order to avoid undue revision of the main text of SIPs, information and instructions which may change frequently will be included (whenever appropriate) in the SIP as attachments. These attachments will be referred to in the main text and in the List of Contents. They will be approved by the Regional Section Head concerned and have the same distribution as the main part(s) of the SIP.

Obligatory items to be included as attachments are:

11.1 Procedures for Application of and Use of Instruments and Equipment

The content of this section is self explanatory.

11.2 Inspection Working Papers

The Inspection Report is based on information collected by the inspector before, during and even after an inspection. The actual information which has to be collected is influenced by the directives contained in sections 6, 7 and 8 of the SIP and will vary from facility to facility. In order to collect the required information in a systematic and easily comprehensible way, "Inspection Working Papers" will be used. These Inspection Working Papers will show activities to be carried out at the facility and will be arranged according to inspection activity. The completed Inspection Working Paper should also include a summary of his work by the inspector.

During the preparation of model SIP, suitable Inspection Working Papers will be prepared which can be used as typical examples for other SIPs.

ANNEX I

ARRANGEMENT OF SIP

General Part

Part	General Part		Attachment	Country Folder
Content	Main text	Annexes to main text	Working papers, detailed procedures	Minimum content defined in main text
Approved by	Director Division of Operations		Regional Section Head	None required
Distribution	As defined in the List of Distribution			Regional Section file only

Facility Part

Part	Facility Part		Attachment	Facility Folder
Content	Main text	Annexes to main text	Working papers, detailed procedures	Minimum content defined in main text
Approved by	Director Division of Operations		Regional Section Head	None required
Distribution	As defined in the List of Distribution			Regional Section file only

S. I. P.
SAFEGUARDS IMPLEMENTATION PRACTICES

Page No. 1 of 4
Date 1975-04-10
Prep. by G. Frank
Distribution "A"

Background material for chapter 6 of the SIP
Outline - General Part
Approved ....
(Director, Division of Operations)

Concealment methods for diversion possibilities connected with transfers of nuclear material between MBAs (or facilities)

1. Although in principle all concealment methods are countered if a quantitative evaluation of each term in the material balance equations for the relevant MBAs or facilities is made, it is useful to point out some typical diversion routes possible with transferred nuclear material - because of the limitations of the safeguards implementation practices employed for the above evaluation.

2. As these diversion possibilities are the outcome of possible interaction between MBAs (or facilities) they should be dealt with in the general part of the SIP for each country.

3. In order to separate the problems connected with movements of nuclear material between MBAs (or facilities) from the known problems of physical inventory verification, delayed reports, etc, in this analysis the following assumption is made:

   a) After each P.I. verification a quantitative conclusion can be drawn so that any diversion will be detected immediately after.

   In addition the following assumptions are also introduced:

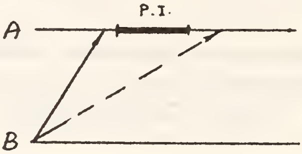
   b) There may be collusion between MBAs (or facilities).

   c) Shipments from one MBA are received in another after a certain time interval which cannot be controlled by the IAEA.

4. Typical diversion possibilities*

4.1 Delay in recording receipt

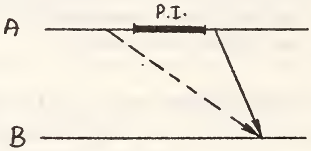
A receipt from MBA (or facility) "B" is received at A before P.I. verification but recorded only after it - so it can be used as a substitute for diverted material during the P.I. verification.



In this case no collusion between A and B is necessary.

4.2 Early (premature) recording of shipment

An intended shipment from A to B is recorded as having been shipped before the P.I. verification while in fact it stays in A until after it. This shipment can be used therefore as a substitute for diverted material during the P.I. verification. No collusion between A and B is necessary.



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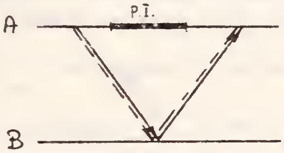
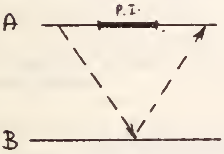
* In the following schemes each horizontal line indicates a time abcissa for a facility (or MBA). Interactions between facilities are shown with arrows: a solid line indicates the actuel time sequence of material transfer, a broken line indicates recorded time sequence of material transfer.

4.3 Inaccessibility of deficient batch

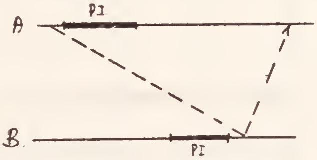
(a) A deficient batch (e.g. an empty container) is shipped out of plant A to B before P.I. verification. It is shipped back to A after the P.I. verification. Collusion between A and B is not mandatory: A can demand the shipment back immediately claiming mistake, before any measurements at B are performed.



(b) If collusion between A and B is possible no real shipment has to take place:

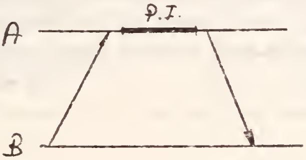


or even



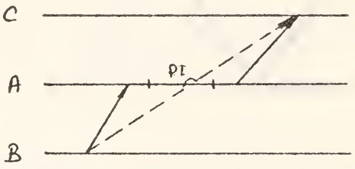
4.4 Borrowing

B ships material to A in order to substitute diversion there during the P.I. verification period. The material is shipped back after the verification. Neither MBA record the transfer. Collusion between A and B is necessary.



4.5 Prolongation of transit time

Material which is intended to be shipped from B to C is delayed on its way in order to substitute diverted material in A during P.I. verification there. The delay can be quite small if the transfer time from B to A, the stay in A and the transfer time from A to C are comparable to the normal transfer time from B to C. Collusion is generally necessary only between A and B, A and C, or A and the transport company.



4.6 It should be noted that many other concealment routes are possible by combining the concealment possibilities mentioned above.

5. Suggested safeguards approach

The suggested approach may include the following measures:

5.1 Advanced notification and sealing of shipments
5.2 Integrated inspection plans
5.3 Simultaneous inspections
5.4 Flow verification and ad hoc or special inspections

The above measures should be elaborated to counter the concealments in paragraph 4 and their limitations should be pointed out in the last paragraph of chap. 6 in the general part of the SIP.

APPENDIX 9
OUTLINE FOR MODEL IAEA SAFEGUARDS INSPECTION REPORT

______/ ______/ ______

SAFEGUARDS RESTRICTED

Total No. of pages ______ Page 1

I. REPORT OF INSPECTION No. type

under agreement

of facility

Category and type of facility:

Inspection conducted by:

AIF/ARIE indication:

Date(s) of inspection:

Date(s) of previous inspection:

Inspection effort spent:

MBA(s)/Accounting area(s) inspected:

II. INSPECTION WORK PERFORMED AND RESULTS

	Description of Activities	MBA(s) (Acc. area)	Planned	Carried out	Page No. of report
1.	Examination of records				
2.	Comparison between records and reports				
3.	Verification of inventory changes				
4.	Updating of book inventory				
5.	Verification of inventory				
6.	Installation and servicing of C and S devices and/or verification of C and S measures				
7.	Verification of quality and functioning of operator's measurement system				
8.	Activities and observations in respect of MUF, SRDs and accidental losses.				

__________ ___/ ______/ ___

Page __________

MBA/Acc. area __________

1.1 Examination of Records

A. Period covered by records examination:

B. Accounting records and the extent to which they have been audited:

C. Operating records and the extent to which they have been audited:

D. Reconciliation of accounting and operating records:
accounting records reconciled with operating records

1.2 Results of Records Examination

A. The records examined are not internally consistent and arithmetically correct.

B. If inconsistencies, including arithmetical mistakes, have been found, specify them:

(a) Number of inconsistencies found:

(b) Description of inconsistencies, including amount and type of nuclear material involved in each inconsistency:

(c) Corrective action:

C. Deviations from the agreed system of accounting and operating records found during the inspection:

______/ _____/ _____

Page ________

MBA/Acc. area ________

2.1 Comparison between records and reports

A. List report identification number(s):

B. Period covered by comparison:

2.2 Results of comparison between records and reports

A. The information in the reports is not compatible with that contained in the facility's records.

B. If any incompatibility has been detected, specify which discrepancies have been found:

(a) Number of discrepancies:

(b) Description of discrepancies, including amount and type of nuclear material involved in each discrepancy:

(c) Corrective action:

C. Deviations from the agreed system of reports found during the inspection:

______/ ______/ ______

Page ______

MBA/Acc. area ______

3.1 Verification of inventory changes

A. Period covered by verification:

B. Total No. of inventory changes for the period:

C. No. of inventory changes verified:

D. No. of samples taken:

3.2 Results of verification of inventory changes

A. Detailed results of verification - see page ____

B. Percentage of nuclear material verified:

C. Verified inventory changes found to be significantly different from operator's data:

D. Verified receipt batches for which SRDs were found by the Agency:

(a) to be significant:

(b) to be significantly different from SRDs stated by operator:

E. Results of verification do not confirm the operator's data on the inventory changes recorded in the accounting records.

3.2.A/5.2.A Detailed results of verification ______/______/______

Page ______ MBA/Acc.area ______

No.	Inventory changes/Groups of inventory items														Verification methods	
	Identification of inventory change/ group of inventory items	Material Description	Operator's data						As verified							
			No. of items	Element			Fissile Isotope		No. of items	Element			Fissile Isotope		Codes	Details
				Code	Weight	kg/g	Weight (g)	Code		Code	Weight	kg/g	Weight (g)	Code		

Details:

Verification Method Codes: A - Identification and counting B - Weighing C - Volume determination D - Sampling and analysis E - Non-destructive quantitative F - Non-destructive qualitative G - Criticality check

______/______/___

Page ______

MBA/Acc. area ______

4.1 Updating of book inventory

A. Period covered by updating:

4.2 Updated book inventory as of:

A. Book inventory according to material categories:

Material Category	Operator's data				
	Element			Fissile Isotope	
	Code	Weight	kg/g	Weight (g)	Code

______/ ____/ ____

Page ______

MBA/Acc.area ______

5.1 Verification of Inventory

A. Type of verification:

B. Categories and description of material covered by verification (in case of interim inventory verification only):

C. No. of samples taken:

5.2 Results of verification of inventory as of:

A. Detailed results of verification - see page(s) ______

B. Inventory data from 5.2.A consolidated according to material categories:

Material Category	Operator's data					Total differences between operator's data and the data as verified	
	Element			Fissile Isotope			
	Code	Weight	kg/g	Weight (g)	Code	Element	Fissile Isotope

C. Percentage of inventory verified:

D. Verified batches found to be significantly different from operator's data:

E. Results of verification do not confirm the operator's data on the inventory recorded in the accounting records

3.2.A/5.2.A Detailed results of verification ____/____/____

Page ____ MBA/Acc.area ____

No.	Inventory changes/Groups of inventory items															Verification methods	
	Identification of inventory change/ group of inventory items	Material Description	Operator's data						As verified							Codes	Details
			No. of items	Element			Fissile Isotope		No. of items	Element			Fissile Isotope				
				Code	Weight	kg/g	Weight (g)	Code		Code	Weight	kg/g	Weight (g)	Code			

Details:

Verification Method Codes: A – Identification and counting B – Weighing C – Volume determination D – Sampling and analysis E – Non-destructive quantitative F – Non-destructive qualitative G – Criticality check

______/ ____/ ____

Page ________

MBA/Acc.area ________

6.1 Installation and servicing of C and S devices and/or verification of C and S measures - Seals:

A. Seals the removal of which requires advance notice to the Agency:

(a) Serial number and location of seal(s) removed by the operator since the previous inspection and amount and type of nuclear material involved:

(b) Reasons for removal given by the operator:

(c) Actions taken to verify the above reasons:

(d) Results of the verification are not considered satisfactory.

B. Number of seals other than those under 6.1.A above removed by operator since the previous inspection:

C. Number of seals removed during the inspection:

D. Total number of seals examined during the inspection:

E. Number of seals attached during the inspection:

F. Total number of seals after the inspection:

G. Serial number and location of seals found damaged or tampered with and amount and type of nuclear material involved:

Page _______

MBA/Acc. area _______

6.2 Installation and servicing of C and S devoces and/or verification of C and S measures - Devices other than seals.

A. C and S devices, other than seals, serviced or installed during the inspection:

B. Results of surveillance devices for the period from

to :

C. Results do not agree with the operator's records.

D. Results of other safeguards instruments installed for the period from to :

E. Results do not agree with the operator's records.

F. Evidence of tampering with or damage to C and S devices and other safeguards instruments:

____________/ _____/ _____

Page ______

MBA/Acc. area ______

7.1 Verification of quality and functioning of operator's measurement system

______/ ______/ ______

Page______

MBA/Acc.area______

8.1 Activities and observations in respect of MUF, SRDs and accidental losses

_______________/ _______/ _____

Page _______

III. ANOMALIES

IV. RECOMMENDATIONS MADE IN THE COURSE OF INSPECTION

V. FINANCIAL LIABILITY INCURRED DURING THE INSPECTION

Report prepared by:

_______________ on _______________

(Inspector(s))

Report approved by:

_______________ on _______________

(Country Officer)

_______________ on _______________

(Section Chief)

Report reviewed by:

_______________ on _______________

(Accounts and Reports)

Report accepted by:

_______________ on _______________

(Director, Division of Operations)

Communication to the State dispatched

_______________ on _______________

(Country Officer)

Filed by:

_______________ on _______________

APPENDIX 10

WORLD NUCLEAR FACILITIES NOT SUBJECT TO SAFEGUARDS

Country	Facility
Argentina	Small reprocessing plant
Egypt	Inshas research reactor
India	Cirus research reactor
	Apsara research reactor
	Zerlina research reactor
	Purnima research reactor
	Fuel fabrication plant
	Reprocessing plant
Israel	Dimona research reactor
Japan	Experimental uranium enrichment plant
Pakistan	Small reprocessing plant
South Africa	Prototype uranium enrichment plant
	Pelindaba research reactor
Spain	Pilot reprocessing plant
	Vandellos power reactor (jointly operated and controlled with France)

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PAGE 02 BONN 10706 01 OF 03 011912Z

THE GOVERNMENT OF THE FEDERATIVE REPUBLIC OF BRAZIL

ON THE BASIS OF THE FRIENDLY RELATIONS EXISTING BETWEEN THEIR COUNTRIES WHICH THEY ARE DETERMINED TO INTENSIFY,

MINDFUL OF AND IN CONTINUATION OF THE AGREEMENT CONCLUDED BETWEEN THE CONTRACTING PARIES ON JUNE 9, 1969, CONCERNING COOPERATION IN SCIENTIFIC RESEARCH AND TECHNOLOGICAL DEVELOPMENT,

IN CONSIDERATION OF THE AGREEMENT OF JUNE 9, 1961 ABOUT COOPERATION IN THE PEACEFUL USES OF ATOMIC ENERGY BETWEEN THE EUROPEAN ATOMIC COMMUNITY AND THE GOVERNMENT OF THE FEDERATIVE REPUBLIC OF BRAZIL,

IN CONSIDERATION OF THE PROGRESS IN SCIENTIFIC COOPERATION BETWEEN THEIR COUNTRIES, ESPECIALLY IN THE FIELD OF THE PEACEFUL USES OF NUCLEAR ENERGY,

CONVINCED THAT THE SUCCESSFUL SCIENTIFIC COOPERATION BETWEEN THEIR COUNTRIES IN THE FIELD OF THE PEACEFUL USES OF NUCLEAR ENERGY CREATES GOOD PRECONDITIONS FOR INDUSTRIAL COOPERATION IN THIS FIELD,

AWARE THAT SUCH COOPERATION WILL BE OF ECONOMIC AND SCIENTIFIC UTILITY FOR BOTH CONTRACTING PARTIES,

WITH REGARD FOR THE GUIDELINES OF OCTOBER 3, 1974, FOR INDUSTRIAL COOPERATION BETWEEN THE FEDERAL REPUBLIC OF GERMANY AND THE FEDERATIVE REPUBLIC OF BRAZIL IN THE FIELD OF THE PEACEFUL USES OF NUCLEAR ENERGY,

ARE AGREED AS FOLLOWS:

ARTICLE 1

(1) THE CONTRACTING PARTIES SUPPORT, WITHIN THE FRAMEWORK OF THIS AGREEMENT, COOPERATION BETWEEN SCIENTIFIC AND TECHNOLOGICAL RESEARCH INSTITUTIONS AND ENTERPRISES IN THE TWO STATES, WHICH INCLUDES THE

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ACTION EUR-12

INFO OCT-01 ARA-10 EA-10 IO-10 ISO-00 CIAE-00 DODE-00

PM-03 H-02 INR-07 L-03 NSAE-00 NSC-05 PA-02 PRS-01

SP-02 SS-15 USIA-15 ERDA-07 ACDA-10 EB-07 NRC-07

OES-05 FEAE-00 MC-02 /136 W

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R 011901Z JUL 75
FM AMEMBASSY BONN
TO SECSTATE WASHDC 1134
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AMEMBASSY BUENOS AIRES
AMEMBASSY LONDON
AMEMBASSY OTTAWA
AMEMBASSY PARIS
AMEMBASSY TOKYO
AMCONSUL RIO DE JANEIRO
USMISSION EC BRUSSELS
USMISSION IAEA VIENNA

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DCA ________
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SAS ________
MC ________

UNCLAS SECTION 01 OF 03 BONN 10706

E. O. 11652: N/A
TAGS: TECH, GW, BR
SUBJECT: GERMAN-BRAZILIAN NUCLEAR AGREEMENT

AN INFORMAL TRANSLATION OF THE GERMAN TEXT OF SUBJECT AGREEMENT FOLLOWS:

AGREEMENT BETWEEN THE GOVERNMENT OF THE FEDERAL REPUBLIC OF GERMANY AND THE GOVERNMENT OF THE FEDERATIVE REPUBLIC OF BRAZIL CONCERNING COOPERATION IN THE FIELD OF THE PEACEFUL USES OF NUCLEAR ENERGY

THE GOVERNMENT OF THE FEDERAL REPUBLIC OF GERMANY

AND

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FOLLOWING:

- PROSPECTING, MINING AND PROCESSING OF URANIUM ORES AS WELL AS THE PRODUCTION OF URANIUM COMPOUNDS,
- PRODUCTION OF NUCLEAR REACTORS AND OTHER NUCLEAR ENERGY FACILITIES AS WELL AS THEIR COMPONENT PARTS,
- URANIUM ENRICHMENT AND ENRICHMENT SERVICES,
- PRODUCTION OF FUEL ELEMENTS AND REPROCESSING OF IRRADIATED FUELS

(2) THE ABOVE-MENTIONED COOPERATION INCLUDES THE EXCHANGE OF THE NECESSARY TECHNOLOGICAL INFORMATION.

(3) WITH REGARD TO THE SIGNIFICANCE WHICH FINANCING INCLUDING THE PROVISION OF CREDIT HAS FOR THE ABOVE MENTIONED COOPERATION, THE CONTRACTING PARTIES WILL MAKE EFFORTS TO GRANT FINANCING AND CREDITS AT THE MOST

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67
ACTION EUR-12

INFO OCT-01 ARA-10 EA-10 IO-10 ISO-00 CIAE-00 DODE-00
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SP-02 SS-15 USIA-15 ERDA-07 ACDA-10 EB-07 NRC-07
OES-05 FEAE-00 MC-02 /136 W
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R 011901Z JUL 75
FM AMEMBASSY BONN
TO SECSTATE WASHDC 1135
INFO AMEMBASSY BRASILIA
AMEMBASSY BUENOS AIRES
AMEMBASSY LONDON
AMEMBASSY OTTAWA
AMEMBASSY PARIS
AMEMBASSY TOKYO
AMCONSUL RIO DE JANEIRO
USMISSION EC BRUSSELS
USMISSION IAEA VIENNA

UNCLAS SECTION 02 OF 03 BONN 10706

FAVORABLE CONDITIONS POSSIBLE UNDER THE REGULATIONS EXISTING IN BOTH STATES.

ARTICLE 2

THE CONTRACTING PARTIES DECLARE THAT THEY COMMIT THEMSELVES TO THE PRINCIPLE OF THE NON-PROLIFERATION OF NUCLEAR WEAPONS.

ARTICLE 3

(1) EACH CONTRACTING PARTY WILL, ON APPLICATION OF AN EXPORTER AND UNDER ITS APPLICABLE REGULATIONS, GRANT

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EXPORT AUTHORIZATIONS FOR THE DELIVERY INTO THE TERRITORY OF THE OTHER CONTRACTING PARTY OF SOURCE AND SPECIAL FISSIONABLE MATERIAL AND OF EQUIPMENT AND MATERIALS WHICH ARE SPECIALLY PROVIDED OR PREPARED FOR THE PRODUCTION, THE UTILIZATION OR PROCESSING OF SPECIAL FISSIONABLE MATERIAL, AS WELL AS FOR THE TRANSFER OF RELEVANT TECHNOLOGICAL INFORMATION.

(2) SUCH DELIVERY OR TRANSFER PRESUMES THAT AN AGREEMENT HAS BEEN CONCLUDED WITH THE IAEA CONCERNING THE SAFEGUARDS MEASURES APPLICABLE TO THE RECEIVING PARTY, WHICH ENSURES THAT THESE NUCLEAR MATERIALS, EQUIPMENT AND FACILITIES AND THE SOURCE AND SPECIAL FISSIONABLE MATERIAL PRODUCED, PROCESSED OR USED IN THEM, AS WELL AS THE RELEVANT TECHNOLOGICAL INFORMATION, WILL NOT BE USED FOR NUCLEAR WEAPONS OR OTHER NUCLEAR EXPLOSIVES.

ARTICLE 4

(1) NUCLEAR MATERIALS, EQUIPMENT AND FACILITIES, AS WELL AS RELEVANT TECHNOLOGICAL INFORMATION, WHICH WERE EXPORTED OR TRANSFERRED FROM THE TERRITORY OF ONE CONTRACTING PARTY INTO THE TERRITORY OF THE OTHER, MAY ONLY BE EXPORTED, RE-EXPORTED OR TRANSFERRED FROM THE TERRITORY OF THE CONTRACTING PARTIES TO THIRD COUNTRIES, WHICH WERE NOT NUCLEAR WEAPONS STATES ON JANUARY 1, 1967, IF WITH RESPECT TO THE RECEIVING STATE AN AGREEMENT HAS BEEN CONCLUDED ABOUT SAFEGUARDS MEASURES AS PROVIDED IN ARTICLE 3.

(2) SENSITIVE NUCLEAR MATERIALS, EQUIPMENT AND FACILITIES, AS WELL AS RELEVANT TECHNOLOGICAL INFORMATION, WHICH WERE EXPORTED OR TRANSFERRED FROM THE TERRITORY OF A CONTRACTING PARTY INTO THE TERRITORY OF THE OTHER, MAY BE EXPORTED, RE-EXPORTED OR TRANSFERRED TO THIRD COUNTRIES ONLY WITH THE CONSENT OF THE SUPPLIER CONTRACTING PARTY.

(3) SENSITIVE NUCLEAR MATERIALS, EQUIPMENT AND FACILITIES ARE:

A. URANIUM ENRICHED TO MORE THAN 20 PER CENT U-235, U-233 AND PLUTONIUM WITH THE EXCEPTION OF SMALL QUANTITIES OF THESE MATERIALS WHICH ARE NECESSARY, FOR EXAMPLE, FOR LABORATORY PURPOSES,
B. FACILITIES FOR PRODUCTION OF FUEL ELEMENTS, IF THEY ARE USED FOR THE PRODUCTION OF FUEL ELEMENTS WHICH CONTAIN A MATERIAL MENTIONED UNDER A. (ABOVE),
C. FACILITIES FOR THE REPROCESSING OF IRRADIATED FUEL ELEMENTS,
D. URANIUM ENRICHMENT FACILITIES.

ARTICLE 5

(1) EACH CONTRACTING PARTY WILL TAKE THE MEASURES WHICH ARE NECESSARY TO GUARANTEE THE PHYSICAL PROTECTION OF THE NUCLEAR MATERIALS, EQUIPMENT AND FACILITIES IN ITS TERRITORY AS WELL AS DURING TRANSPORTATION BETWEEN THE TERRITORIES OF THE CONTRACTING PARTIES AND IN THIRD COUNTRIES.

(2) THESE MEASURES WILL BE SO DESIGNED THAT THEY AVOID, SO FAR AS POSSIBLE, DAMAGE, ACCIDENT, THEFT, SABOTAGE, ROBBERY, MIS-SHIPMENT, DETERIORATION, EXCHANGE AND OTHER RISKS.

(3) THE CONTRACTING PARTIES WILL AGREE ON SUITABLE MEASURES FOR THIS PURPOSE.

Department of State TELEGRAM

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67
ACTION EUR-12

INFO OCT-01 ARA-10 EA-10 IO-10 ISO-00 CIAE-00 DODE-00

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TO SECSTATE WASHDC 1136
INFO AMEMBASSY BRASILIA
AMEMBASSY BUENOS AIRES
AMEMBASSY LONDON
AMEMBASSY OTTAWA
AMEMBASSY PARIS
AMEMBASSY TOKYO
AMCONSUL RIO DE JANEIRO
USMISSION EC BRUSSELS
USMISSION IAEA VIENNA

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ARTICLE 6

THE MIXED COMMISSION ESTABLISHED BY THE AGREEMENT OF JUNE 9, 1969 ON COOPERATION IN SCIENTIFIC RESEARCH AND TECHNOLOGICAL DEVELOPMENT WILL GIVE DUE CONSIDERATION TO THE ACTIVITIES ENVISAGED UNDER THE PRESENT AGREEMENT AND WILL MAKE IF NECESSARY PROPOSALS FOR ITS FURTHER IMPLEMENTATION.

ARTICLE 7

AT THE REQUEST OF EITHER CONTRACTING PARTY, THE

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CONTRACTING PARTIES WILL CONSULT ON THE IMPLEMENTATION OF THIS AGREEMENT AND, IF NECESSARY, UNDERTAKE NEGOTIATIONS FOR ITS REVISION.

ARTICLE 8

(1) THE CONTRACTING PARTIES WILL ENDEAVOR TO RESOLVE DIFFERENCES OF OPINION ABOUT THE INTERPRETATION OF THIS AGREEMENT THROUGH DIPLOMATIC CHANNELS.

(2) IF DIFFERENCES OF OPINION CAN NOT BE RESOLVED IN THIS MANNER, AN ARBITRATION WILL TAKE PLACE AS IS PROVIDED IN ARTICLE 10 OF THE TREATY OF JUNE 7, 1972, BETWEEN THE CONTRACTING PARTIES CONCERNING THE ENTRY OF NUCLEAR-PROPELLED SHIPS INTO BRAZILIAN WATERS AND THEIR DOCKING IN BRAZILIAN PORTS.

ARTICLE 9

THE OBLIGATIONS OF THE FEDERAL REPUBLIC OF GERMANY UNDER THE AGREEMENT FOR THE FOUNDATION OF THE EUROPEAN COMMUNITY AND FOR THE FOUNDATION OF THE EUROPEAN ATOMIC COMMUNITY ARE NOT AFFECTED BY THIS AGREEMENT.

ARTICLE 10

THIS AGREEMENT IS ALSO APPLICABLE IN LAND BERLIN IN SO FAR AS THE GOVERNMENT OF THE FEDERAL REPUBLIC OF GERMANY DOES NOT MAKE A CONTRARY DECLARATION TO THE GOVERNMENT OF THE FEDERATIVE REPUBLIC OF BRAZIL WITHIN THREE MONTHS AFTER THE ENTRY INTO FORCE OF THIS AGREEMENT.

ARTICLE 11

(L) THIS AGREEMENT WILL BE BROUGHT IN FORCE AS QUICKLY AS POSSIBLE BY EXCHANGE OF NOTES.

(2) THIS AGREEMENT WILL BE IN FORCE FOR 15 YEARS FROM THE DAY SET IN ACCORDANCE WITH SECTION 1 BY THE EXCHANGE OF NOTES AND WILL, IN SO FAR AS THE AGREEMENT IS NOT TERMINATED BY ONE OF THE CONTRACTING PARTIES AT

LEAST 12 MONTHS BEFORE IT EXPIRES, TACITLY BE EXTENDED FOR PERIODS OF FIVE YEARS.

(3) THE SAFEGUARDS AND PHYSICAL SECURITY MEASURES REQUIRED AS A CONSEQUENCE OF THIS AGREEMENT WILL NOT BE AFFECTED BY THE TERMINATION OF THIS AGREEMENT.

DONE AT BONN ON JUNE 27, 1975 IN TWO ORIGINAL COPIES, ONE IN THE GERMAN AND ONE IN THE PORTUGUESE LANGUAGES, EACH TEXT BEING EQUALLY AUTHENTIC.

FOR THE GOVERNMENT OF THE FEDERAL REPUBLIC OF GERMANY   FOR THE GOVERNMENT OF THE FEDERATIVE REPUBLIC OF
BRAZIL

END INFORMAL TRANSLATION
HILLENBRAND

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